POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

Contents

The Power of Expanding Gases 384
With the Editors 385
That What is Not—Can Be, and Will Be.
Springfield's New Lakeside Station. By S. J. Sibley and F. N. Glazier 386
New Standards for Commercial Refrigerating Units. By Glenn Muffly 393
Flue Gas Weights Calculated from Fuel Analyses. By J. R. Darnell 394
Research Trends in the Power Industry. By C. F. Hirshfeld 398
Operating the Turbine Auxiliaries. By Paul F. Rogers 401
Combustion Control. Part XVII 403
Waste Heat Recovery from Diesels. By E. G. Sims 407
Oil Maintenance in Industrial Plant Breakers. By K. B. Humphrey 409
Electron Tubes—Principles and Applications. Part VI. By A. W. Kramer 410
Linemen Brave Blizzards to Maintain Power Service. By C. W. Geiger 414
Booster Compressor Cuts Power Bills 415
Seals Against Fluid Pressures. Part III 416
Foreign Substances in Boilers. By C. C. Custer 419
N.D.H.A. Radiates Optimism 420
Dairy Plant Refrigeration. By J. T. Winslow 422
The Combustion Engineer. By N. T. Pef 424
Table of Latent Heat of Vaporization. By Fred J. Wiegand 425
Utility Leaders Defend Industry's Record at St. Louis Meeting 426
Reader's Conference 431
New Equipment 434
News from the Field 438
For the Engineer's Library 438
Power Plant Construction News 442

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

JULY
1936

Vol. XL., No. 7

Published on the first of each month, copyright 1936 by the
Technical Publishing Co., 53 W. Jackson Blvd., Chicago.
New York Office, 171 Madison Ave.

EDITORIAL STAFF: ARTHUR L. RICE, Editor. R. E. TURNER, Managing Editor.
A. W. KRAMER, RICHARD H. MORRIS, Associate Editors.

Subscription price. U. S. A. $2.00 a year; other countries, $3.50 a year. Single copy current issue, 25c; other countries, 35c. January issue, U. S. A., 50c; other countries, 60c. Back issues, single copy, U. S. A., 40c; other countries, 50c. January issue, U. S. A., 75c; other countries, 85c.

Member, Associated Business Papers, Audit Bureau of Circulations.
Circulation of this issue, 19,900

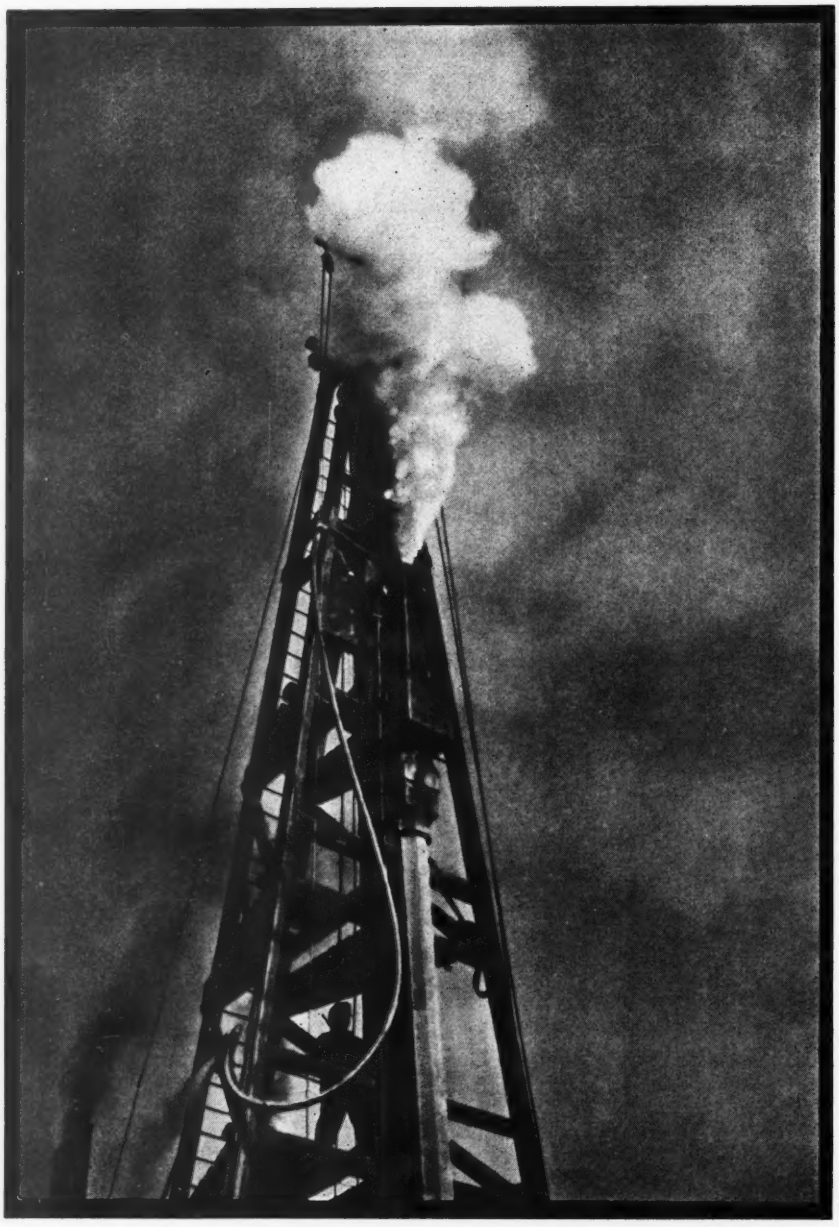


Photo. Baranger

The Power of Expanding Gases

FEW THINGS have so changed the face of the earth as has man's control over the power of expanding gases. Used first in the case of gunpowder, the use of the energy of expanding gas may be regarded as one of the two major inventions of historical times. The other great discovery was that of the electrical transmission of power. With gunpowder the modern engine had its beginning for the gun is a one-cylinder internal combustion engine which blows its piston to remote distances. It was but a step to attach a rod to the projectile, transform its flight into a rotary motion and thus haul the projectile back into the cylinder after each explosion where it could be shot out again. In this principle lies largely the power of the western world. It gives us the mastery over space and material that our forefathers did not have. The pile driver shown above is a simple application of this principle but that little puff of steam symbolizes one of man's greatest achievements over the forces of nature. The controlled power of the steam engine and the internal combustion engine is still man's greatest asset.

WITH THE EDITORS

That What Is Not—Can Be, and Will Be

SPONSORED by the local chamber of commerce, Schenectady, N. Y., celebrated its half century of electrical progress on June 12 and 13 to commemorate the establishment of the electrical industry there by Thomas Alva Edison. It was just 50 yr. ago on June 14 that Edison took title to two abandoned shops of the McQueen Locomotive Co. as a new location for the Edison Machine Works, thus laying the foundation for a local industry which later developed into the present General Electric Co. and thus starting Schenectady on its path to fame as the world capitol of electrical progress.

It is not our purpose here to describe this celebration but rather to consider some of its implications and in particular to quote a few lines from the splendid address of Owen D. Young delivered upon the occasion. For the growth and development of the electrical industry has inherent in it a lesson which we may well heed in these days of apprehension and uncertainty in regard to the future.

The tangible growth of the electrical industry is obvious enough. In Schenectady its development from two buildings to 674 or from 70,000 sq. ft. of floor space to 6½ millions or from 300 employees to 24,000 needs no interpretation. These things speak for themselves.

What is more important than the tangible growth is the reason why. What was the power, the driving force that created the great something of today out of the nothing of 50 yr. ago? As Owen D. Young said, to make that discovery would be helpful not only in interpreting the history of the 50 yr. gone by, but it would enable us all better to forecast our future. Have we the necessary ingredients today to duplicate that growth?

"For the past six years," said Mr. Young, "we have been advised on every hand to be realistic. This, I suppose, is the reaction against the alleged mirages of the 20's. Youngsters without practical experience were the ones in earlier generations who dreamed dreams and who complained of their elders for want of vision. In this generation these same youngsters profess to be hard boiled realists who look at affairs so objectively and with such assurance that they warn their elders against being misled by the dreams of yesterday.

"The heart of this realistic philosophy," continued Mr. Young, "seems to be that what is—is, and that what is not—can't be; that our problem is to divide what we have and be content; that youth can no longer look forward to the progress which the past has known, that the research worker, the inventor and the engineer are enemies rather than benefactors of society; that we must surrender our visions and our hopes for the drab treadmill of a living in which the talented and untalented alike, the industrious and the lazy shall have equality in recognition and division. If this occasion has any significance for the future it is to deny that such alleged realism is real at all. It would be more correct to say that what is—is not, and what is not—will be.

"Broadly speaking, there never was a time during the past 50 yr. when anything manufactured by the General Electric Co. was not, to some extent at least, obsolete by the time that it was put in service. So rapidly came invention and improvement, fostered by research, that in this growing art it could never be said and cannot be said today that what is—is. It could only truthfully be said that what is—is not, in the sense that what is is too obsolete ever to be built again. The statement is also equally false that what is not—can't be. The whole history of the 50 yr. shows that what is not—can be, and will be."

It would be presumptuous to attempt to add to such wisdom as is Mr. Young's and it is not in that sense that we present our comments here. We cannot, however, resist the temptation to emphasize this idea of vision that is implied in Mr. Young's address, for we in the power industry need that vision as much as any group in the world today.

For power, and all that the term implies in an energy sense, is the common denominator of our material civilization, and its proper and effective production and utilization in the future depends to a great extent upon our perspective in regard to it.

At the Edison Electric Institute Convention, reported elsewhere in these pages, there was much discussion of the electric power industry, much of which was intelligent and fair, nor was it lacking in vision. There seemed to be, however, too universal a tendency to accept those ideas which are favorable to the utilities, and to oppose, as a matter of principle, those ideas which are advanced by the opposition—too much of an attitude of "what is—is, and what is not can't be." In referring to this we do so not in a critical mood, for we realize that the utility leaders are justified in many of their views, but it seemed that perhaps at a convention of this kind it would be a good idea to invite some of the opposition and have them present their views. There might be argument, of course, but no sound theory or philosophy has ever been damaged by taking it out into the open, and it is possible that by so doing both sides would benefit through better understanding.

With regard to the technical side of electrical progress we need have no fears—the 50 yr. record proves that. Concerning the economic and social aspects of electrical power, however, there is much divergence of opinion, much of which is based on emotion and prejudice rather than on sound knowledge and it is in this direction that we should seek to bring about better understanding. We will do well to heed Owen D. Young's words—"It is not what is today for which we plan, it is what will be tomorrow, and what tomorrow will bring depends upon our spirit of approach today."

SPRINGFIELD'S NEW

Illinois' capital city builds a new pumping station and power plant at Spaulding Dam to take care of increasing demands. Initial section has one 110,000 lb. per hr., 450 lb. pulverized coal boiler and one 10,000 kw. turbine.

By S. J. SIBLEY, Superintendent Electric Light & Power Department and F. N. GLAZIER, Mechanical Superintendent Lakeside Station

SEVERAL YEARS AGO, rapidly increasing demands on the generating and pumping facilities of the Springfield, Ill., municipal system, made plans for capacity extension imperative. As natural conditions at Riverside Station on Sangamon River allowed only limited expansion, it was decided to develop Lake Springfield by building a dam across Sugar Creek about 2 mi. southeast of the city limits. The 1300 ft. dam, named after Willis J. Spaulding, Commissioner of Public Properties since 1911 and built under the final direction of Charles H. Spaulding, General Superintendent of the Water, Light and Power Department, was completed in 1934, and now forms a lake 13 mi. long covering an area of 4300 a. to an average depth of 15 ft. The storage capacity of 31.4 billion gal. provides adequate water system and condensing water facilities as well as an attractive recreational area for the city.

At the west end of the dam a plant site of 150 a. giving room for expansion, is served directly by a railroad siding from the nearby coal mines. The decision to use pulverizers was made largely, to handle economically, the low fusing ash coal which underlies this area. In fact, the 36 ft. excavation to hard shale, upon which the foundations rest, extends through a 3 ft. vein of coal.

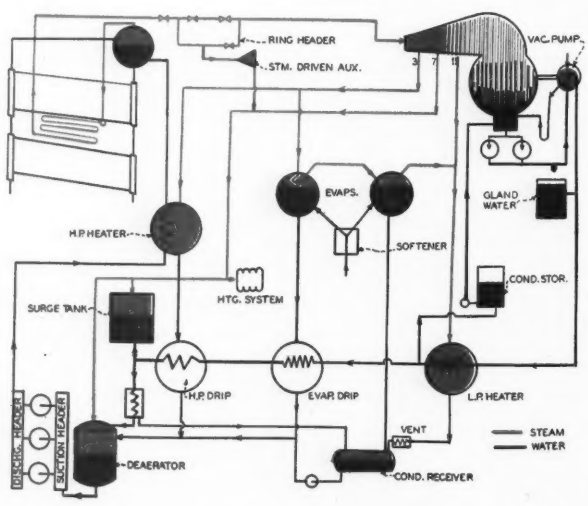


Fig. 1. Flow diagram of the station. The evaporators are piped so that they may be operated double effect from the 3 to 11 stage bleed lines or single effect from the 3 to 7 or 3 to 11 stages

As shown by the architect's drawing, the plant is designed for four sections: The first with one 110,000 lb. per hr., 450 lb. pulverized coal boiler and one 10,000 kw. turbine was put into service late in April and the second section with a 20,000 kw. turbine is now being designed to handle the electric load which increased much faster than anticipated when the first section was started. In the meantime, the old Riverside Station plant on Sangamon River provides standby capacity for the new single boiler and turbine unit at the new plant. The electric system serves 20,000 customers and takes care of the public lighting. The peak load is about 10,000 kw. and the annual output 40 million kw-hr., about double the load in 1927.

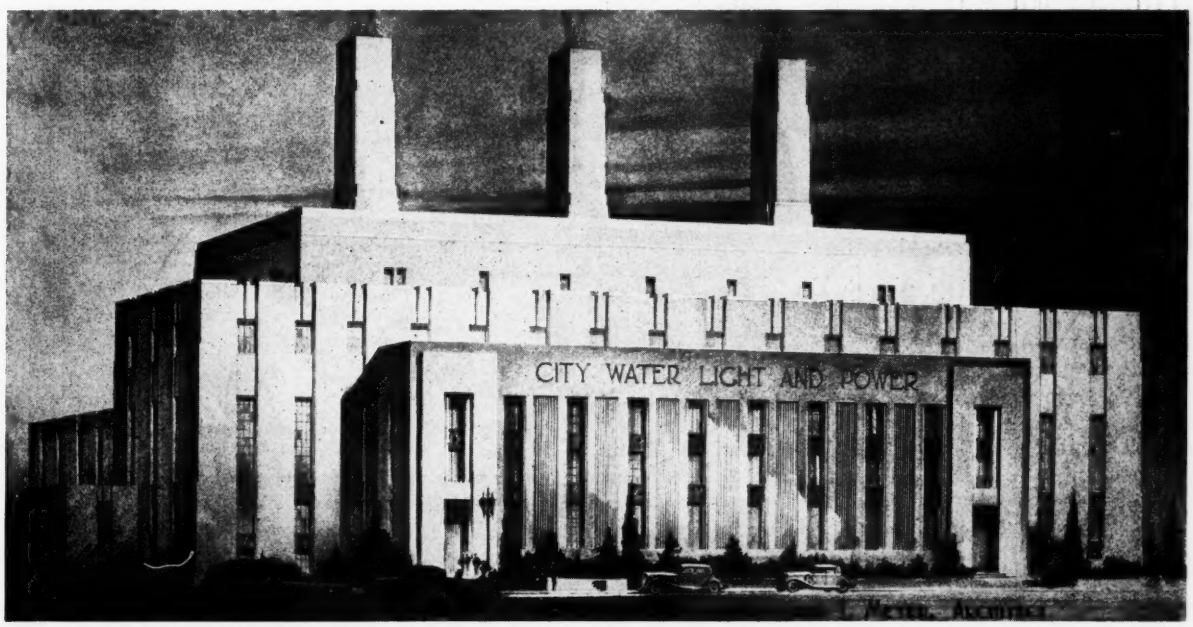
Water Facilities

Both high and low head water works pumps are incorporated in the power plant proper but the filter plant, now under construction, is about 800 ft. farther west. As the normal lake level is elevation 560, the traveling screens, low head pumps and condenser circulating pumps are on the 562 ft. level to permit water to flow from the gate house into the suction tunnels by gravity through twin intake tunnels 700 ft. long. The gate house itself is located 150 ft. out in the lake.

Three intake gates are provided at the gatehouse to secure cold condensing water at a depth of 25 ft. for condensing purposes and to draw water at other depths most suitable for treatment at the filter plant where warmer water is desirable to speed up chemical reactions. The two arched concrete intake tunnels, each with 35 sq. ft. sectional area are cross connected to allow either to be taken out of service for inspection or cleaning. Incoming water passes through Link-Belt revolving screens, the screen chambers and suction tunnels being provided with gates to allow dewatering for inspection and maintenance without interrupting the water supply to the pumps.

A 500 ft. concrete discharge tunnel disposes of the warm condensing water at a point remote from the intake but provisions are made to use, in cold weather,

LAKESIDE STATION



the warm condenser water for filtering plant raw water supply. A 24 in. Allis-Chalmers 13,000 g.p.m. dual-driven circulating water pump is installed directly below the condenser, at elevation 562, for the delivery of lake water from the intake tunnel through the condenser to the discharge tunnel. Normally, this pump is motor-driven. In cases of power interruption, the turbine drive will automatically cut in by means of solenoid valves and pressure switches. For boiler feed make-up, the lake water, treated by a Permutit softener, is used as feed to Westinghouse evaporators, which deliver their vapor output either to the low pressure heater, as shown by the flow diagram, or to the deaerator. When delivery is to the low pressure heater, an automatic pump and receiver set returns condensed vapors to a common condensate system where surge and storage tanks provide for variable water demands.

For the water system at present two Worthington motor-driven, low head centrifugal pumps of 5½ and 9 m.g.d. capacity are installed with provisions for additional capacity as later required. These low head pumps deliver lake water to the filter plant after which it flows to a 2 m.g. clear water storage adjacent to the East side of the pumping station. The low service pumps are automatically primed and remotely controlled from the filter plant. In the high service pump room at Elev. 573 there are one 6 m.g.d. Midwest motor-driven pump, one 10 m.g.d. Worthington motor-driven pump and one 15 m.g.d. DeLaval steam turbine-driven condensing pump. All three of these pumps are automatically primed and take their suction from the clear well storage and deliver to the city mains through piping and valves arranged in ring header design for minimum service interruption.

Generation of Steam

Screened or mine-run coal is dumped from cars into a track hopper and handled by a Robins conveying system. A 75-t. per hr. belt conveyor transports the coal to the top of a crusher house, to an American ringhammer-type crusher arranged so that it may be by-passed for small coal sizes. From the crusher the coal is conveyed and distributed into 300-t. storage bunkers at the top of the boiler house. Delivery of the coal from these bunkers is by gravity downward through Richardson automatic weigh scales and feeders into two Riley 5 t. unit mills. Enco auxiliary oil burners will, in an emergency carry a load of up to 70,000 lb. of steam per hr.

Primary and secondary air for combustion is supplied from a 39,100 c.f.m. at 8½ in. s.p. American forced draft fan motor-driven through a Hydraulic coupling arranged for variable speed and air pressure regulation. The air delivery from the forced draft fan is heated by a Ljungstrom preheater.

Furnace draft is provided by a 72,000 c.f.m. at 8½ in. s.p. American motor-driven, induced draft fan also equipped with variable speed, Hydraulic coupling drive. This fan takes its suction from the discharge boiler outlet through the preheater to a brick stack rising 55 ft. above the boiler house roof.

Flyash in the outgoing flue gases is removed by separating baffles and vanes embodied in the fan de-

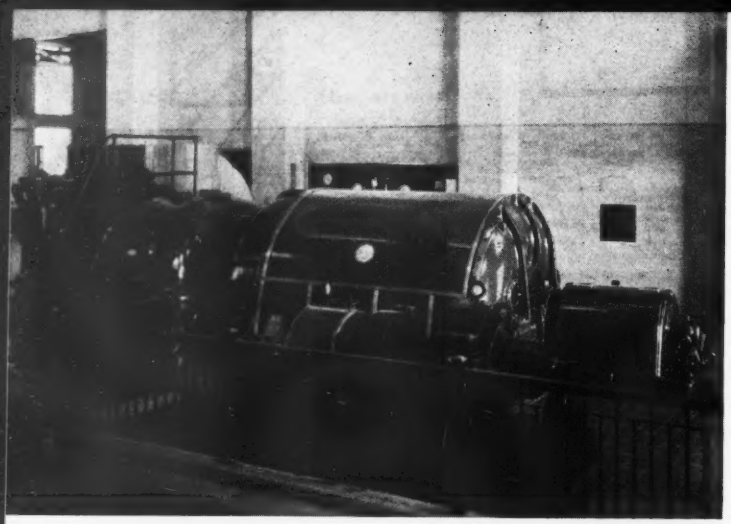


Fig. 2. The 10,000-kw. turbine unit with a totally enclosed direct connected exciter

sign. The ash removed is collected and disposed of through a Hydro-Vac system into an ash pit. The heavier ash particles drop to a hopper from which they are removed through Allen-Sherman-Hoff water jet sluiceways to the ash pit in the basement. Hydroseal ash pumps dispose of the ash to fill a deep ravine 800 ft. from the plant. Water drains off below the dam. A considerable quantity of CO_2 is used in the filter plant and this is supplied from the flue gas by means of a special scrubber and compressor installed just back of the boiler on elevation 588.

Boiler and Furnace

The plant was designed for the use of pulverized fuel exclusively. The coal to be used varies from 14 to 16 per cent moisture, 39 to 41 per cent volatile, 43 to 48 per cent fixed carbon, 13 to 17 per cent ash and from 9000 to 10,500 B.t.u. per lb. Moisture content makes unit pulverization advantageous, to avoid preliminary drying. The ash has a low fusing temperature of 200 deg. F. and is erosive to furnace refractories so water-cooled furnace walls are provided.

The boiler is a 922 hp., single rear cross drum, Springfield, with an interdeck Foster-Wheeler superheater. It will be operated at 420 lb. gage pressure and 700 to 710 deg. F. total steam temperature. Based on boiler surface only, ratings range from 150 to 450 per cent. The price of coal does not justify feed water economizers but an air preheater recovers the waste heat from flue gases.

Furnace volume is 7150 cu. ft. The enclosing furnace walls are of Bigelow-Liptak suspended tile construction. The refractories of the side, rear and hopper walls are protected with water screen tubes having a total exposed surface in the furnace of 1550 sq. ft. In order to provide for the burner openings, the short front wall is constructed of special heat-resisting refractory tile.

Combustion is controlled by a Hagan system, so arranged that firing can be completely automatic, semi-automatic or manual as desired. A boiler panel with all necessary instruments for boiler and furnace control is located at the boiler front where the operator is stationed. The control system, which includes a master panel, will be extended to future boiler units.

The combustion control is so arranged that adjustments may be made for any desired variations in steam pressure, furnace draft, and maximum or minimum boiler load. A feature of adjustment is possible which allows a most sensitive control through the range of loads now prevalent, and with later station load demand increase the load adjustment may be raised to a new load range and still retain its sensitiveness.

Turbine Room

Throttle conditions are for 400 lb. steam pressure with 700 deg. F. total steam temperature. The initial generating unit is 10,000 kw. General Electric turbine and generator. The turbine is a 14-stage, 3600-r.p.m.

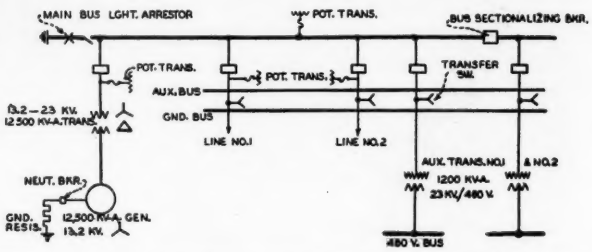


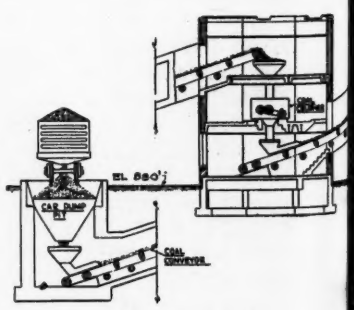
Fig. 3. Single line electrical diagram of the station

machine with provisions for steam extraction for feed water heating and evaporation at the 3, 7 and 11 stages. The generator is rated at 12,500 kv-a. at 13,200 v., 0.8 power factor. The windings are wye-connected, the neutral being grounded through a neutral breaker and grounding resistor as shown on the single line diagram. Excitation is normally from a direct-connected 50 kw., 250 v., d.c. exciter but a separate 100 kw., 250 v., d.c. exciter is provided for emergencies. The direct-connected exciter is totally enclosed and provided with cooling air, filtered to protect the main generator from carbon and copper dust.

Oil for the turbine bearings is cooled and purified. Cooling for the generator windings is provided with an enclosed duct and air circulation through a fin tube cooler. Cooling medium for both air and oil is circulating lake water. Exhaust steam is condensed in a 16,000 sq. ft. Wheeler two-pass surface condenser. Air and non-condensable vapors are removed by a Wheeler steam jet air pump.

Heat Balance

Motor-driven Wheeler centrifugal hot-well pumps discharge the condensate through the steam jet condenser to a low-pressure heater supplied by bleed



steam from the 11th stage. From the low-pressure heater the condensate passes through two coolers to a Cochrane deaerating heater on the 7th stage bleed line.

Allis-Chalmers motor-driven, four-stage boiler feed pumps of 250 g.p.m. capacity deliver the condensate from the deaerating heater at 530 lb. pressure to the boiler through a high-pressure heater, where a final temperature of 320 deg. is secured by use of steam from the third stage bleed point. One of the pumps is steam-driven for emergency service in case of power interruptions. Drains from the several bleeder heaters pass through drip coolers to the deaerating heater either direct or through the condensate receiver as shown on the flow diagram.

For storage of condensate, for boiler refills and evaporator shut downs, a 10,000 gal. storage tank is provided in the basement. In connection with this tank a 150 g.p.m. Union centrifugal pump driven by a 7½ hp. Westinghouse motor delivers condensate from storage either into a boiler fill line or the station condensate system as required. This condensate storage is provided by slowly tapping off hot well pump delivery at periods when evaporators are in service.

Evaporators are used double effect particularly under low station load periods for maximum vapor delivery from minimum amount of third stage steam available at such periods.

Water in the boiler is kept to a predetermined minimum dionic value by means of hand operated valve from the boiler drum through an orifice with an area determined by trial so that dionic value may be reduced proportionately to number of hours the orific blowdown is in service.

For immediate indication of emergency conditions throughout the plant, a station annunciator is mounted on the turbine room panel which notifies the operator of high or low water in the gland seal and surge tanks, low city and feed water pressures, low water levels due to screen obstructions in the circulating water tunnel or low lift pumps suction chamber and excessive temperatures in generator windings, turbine oil or generator air cooler delivery.

Instruments and control facilities are unusually complete. The turbine room panel has in addition to the Crosby indicating gages and Taylor indicating thermometers necessary or desirable for operation, Taylor pressure, temperature and vacuum recorders, two Cochrane flowmeters, one on the steam and the other on the condensate line. In the boiler room the master panel has a Bailey smoke recorder, a Bailey pressure recorder and a Hays CO_2 recorder. On the boiler panel shown in the photograph are: Hays 8 pointer draft gage; Bailey boiler meter; Crosby steam and feed water indicating pressure gages; Taylor steam and feedwater recording pressure gage; Bailey water level recorder; Taylor recording thermometers for gas and air temperatures; and Bailey feedwater flow meter. In the basement are two more panels. One with recording and indicating instruments for the water works pumps, the other, located at the boiler feed pumps, has indicating pressure gages and water level indicators from all parts of the station to guide the operators in charge of the pumps.

Electrical System

The station is equipped throughout with Westinghouse switchgear which incorporates a number of new and interesting features. The generator is connected direct, without circuit breakers, to the low side of a 12,500 kv-a., 3ph., 13,200/23,000 v. Moloney transformer with the low side delta connected and the high side wye connected with the neutral solid to ground. Transformer, switchgear and busses are located west of the station in a separate transformer enclosure and switch house. The arrangement used allows practically direct connection of the transformer, through the generator circuit breaker and a short cable dip under the switch house wall, to the main and auxiliary busses.

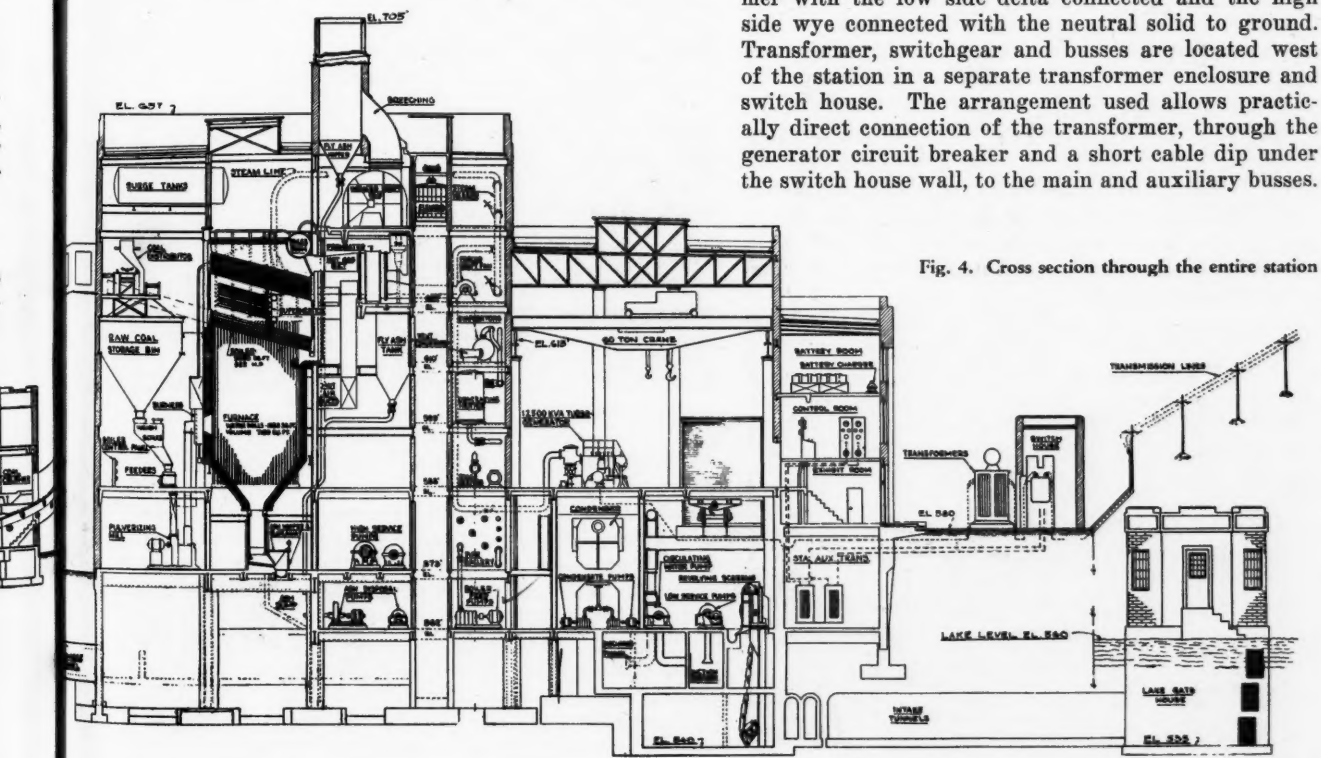


Fig. 4. Cross section through the entire station

Two power feeders are then carried from the busses by transmission lines to the Reynolds Street Substation in the city, where a load dispatcher coordinates power delivery from Lakeside and Riverside Stations with city power demands.

Main switch gear consists of six metal clad, compound filled type breakers including: one generator, two feeder, two station auxiliary transformer and a bus sectionalizing unit as shown by Fig. 7. The circuit breaker units are of the removable lift type O-22-A, rated at 600 amp., 23,000 v. with an interrupting capacity of 500,000-kv-a. All main connections in the stationary units are insulated for 23 kv. and are immersed in soft insulating compound. Metal enclosures provide complete phase isolation. The transfer bus disconnecting switches are oil immersed and are of the three position type, providing a ground connection as well as a connection to the transfer bus and an open switch. These switches are operated by a lever at the front of the unit and are interlocked with the circuit breakers to prevent incorrect operation. All breaker units are completely interchangeable.

Potential transformers are oil filled and are mounted on the top of the structure, three being connected to the bus for metering, two on the generator for synchronizing and voltage regulators and one on each line for synchronizing. The current transformers are mounted at the rear of the unit in a compound filled compartment into which the cable terminals are connected.

A housing at one end of the structure encloses lightning arresters, which are connected to the bus by means of oil-immersed disconnecting switches. The doors to this compartment cannot be opened until the lightning arrester is disconnected and grounded by means of the switches. The bus sectionalizing unit was not equipped with a circuit breaker at present, but is provided with a simple connecting unit which may be replaced by a circuit breaker when the bus is extended. The installation of this unit in the present equipment makes possible the addition of the second bus section in the future, without de-energizing the first bus section.

The breakers are controlled from a benchboard type of main switchboard, Fig. 6, in the control room of the station. This small and compact benchboard is equipped with flush type, miniature type K instruments and Minatrol type control and instrument switches. The miniature bus on the face of the board indicates the main connections. The relays, with their associated test switches, are mounted on swinging panels on the rear of the board. The generator and main transformer are each protected by a set of differential relays. The lines are each protected by type HZ high-speed impedance relays and type CRC ground relays. Type HD high-speed current balance relays are also provided in case it is decided to operate the two feeder lines in parallel. The station auxiliary transformer banks are protected by over-current relays only.

Fig. 6. Bench board in the control room

Watthour meters and totalizing and recording instruments are mounted on a separate vertical switchboard, located at the left of the main benchboard as shown by the photograph. Two additional vertical switchboard panels, facing the main benchboard, include the Allis-Chalmers voltage regulator equipment and the control battery charging control equipment.

Twenty-three thousand volt power is brought back to the station from the switch house through cables in concrete ducts to a transformer vault, where two 1200 kv-a., 23,000/460 Moloney, 3ph., station auxiliary power transformers are located.

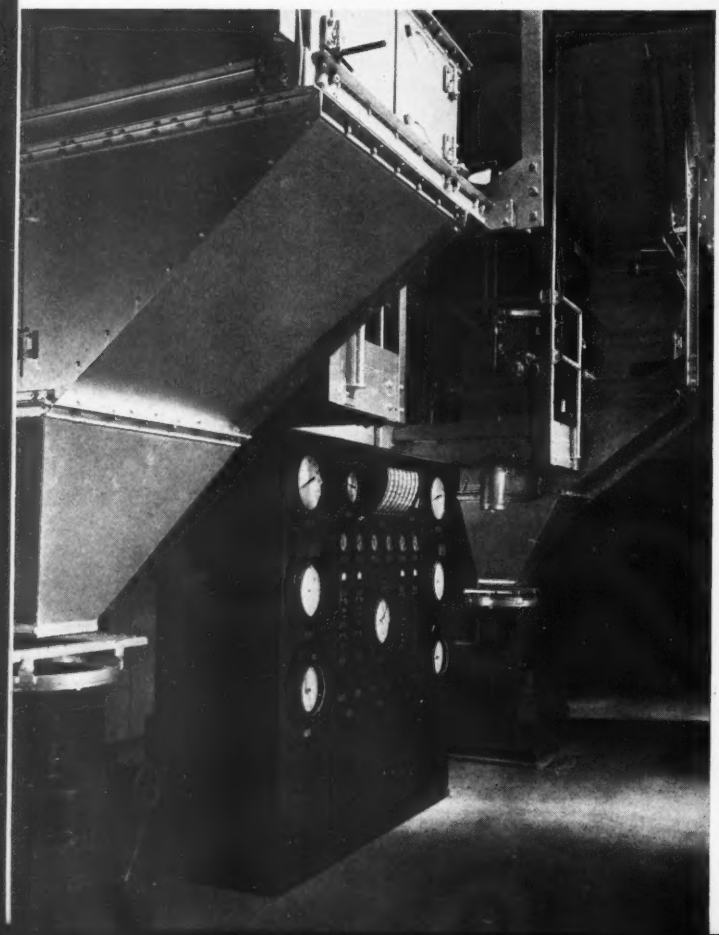


Fig. 5. Boiler control panel and pulverizer feeders

Auxiliary Switchgear

The main 440 v. auxiliary switchboard is located in the control room. Duplicate bus bars on this board are fed from the secondary of the two station transformer banks and two circuit breakers, on each outgoing circuit, provide for connections to either bus. A circuit may be transferred from one bus to the other, but an alarm is sounded continually while the two circuit breakers, for a given circuit, are closed, as protection against the permanent paralleling of the transformer secondaries through these switches. Pilot lights at the top of the board indicate which bus is energized.

Circuits from this main 440 volt board feed seven similar and completely enclosed boards placed at various points about the station, from which the power is distributed to the motors.

Fig. 7. Metal clad breakers in the switch house

Motors are all started directly across the line. The circuit breakers feeding the coal pulverizer, the induced draft fan and the forced draft fan are electrically interlocked to provide for the starting up and shutting down of this equipment in the proper sequence. As an added safety feature for boiler operation an emergency diaphragm pressure actuated switch is installed so that in the event of failure of the induced draft fan or its variable speed drive whereby the induced draft fan suction pressure drops to a tenth of an inch all other combustion auxiliaries are immediately tripped out. Circuit breakers on all of these 440 v. switchboards are of the type AB De-Ion hinged withdrawal type, mounted on hinged frames, provided with main and secondary disconnecting contacts and, when a circuit breaker is open, it can be unlatched and withdrawn for inspection. The circuit breakers on the main board are hand operated, but several of those on the distribution boards are arranged for remote electrical control, either tripping by means of shunt trip coil or complete operation with a motor-operated mechanism.

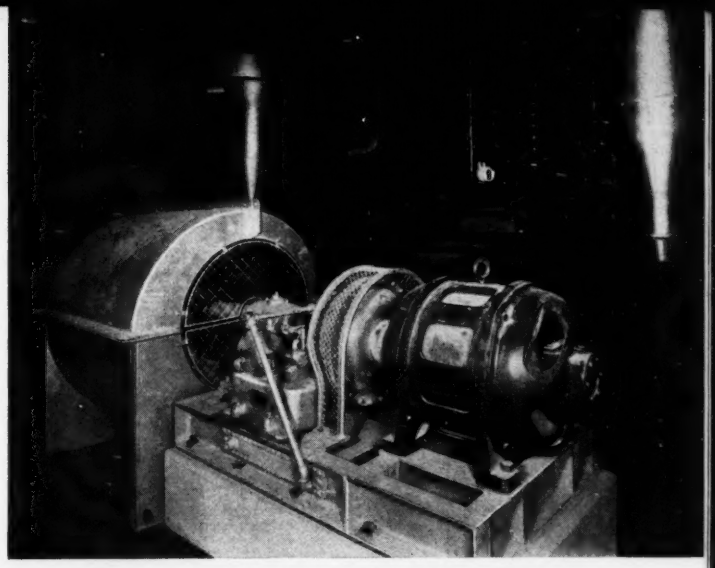


Fig. 8. The forced draft fan showing hydraulic couplings, the dust collecting cyclones from the induced draft fan on the level above

Small, but complete, machine, blacksmith and pipe shops in the station take care of emergency repairs and an elevator serving all floors. At the entrance to the building and office an exhibit room conveniently allows visitors to register and view interesting facts and features pertaining to this municipally owned and operated plant. In line with modern practice, this room is sound-proofed with Acoustone.

Landscaped grounds will border driveways and walks which form the approaches to the building. The simplicity of the architectural pilaster and panel effect in the contour of the building structure will be particularly enhanced with night flood lighting.

The city may feel justly proud of this Lakeside Station. It was designed by Burns & McDonnell Engineering Co., Carl T. Meyer acting as Associate Architect on the building. The boiler and turbogenerator were financed out of funds of the department. The balance of the station cost was financed under a PWA contract with the Federal Government.

(For list of principal equipment see page 392)

Electrical Engineers Elect Officers

Mr. A. M. MacCutcheon, Engineering Vice-President, Reliance Electric and Engineering Company, Cleveland, Ohio, was elected President of the American Institute of Electrical Engineers for the year beginning August 1, 1936, as announced at the annual meeting of the Institute held at Pasadena, Calif., during the annual summer convention of the Institute. The other officers elected were: Vice-Presidents A. C. Stevens, Schenectady, N. Y.; O. B. Blackwell, New York, N. Y.; C. Francis Harding, Lafayette, Ind.; L. T. Blaisdell, Dallas, Tex.; C. E. Rogers, Seattle, Wash.—Directors K. B. McEachron, Pittsfield, Mass.; C. A. Powel, East Pittsburgh, Pa.; R. W. Sorensen, Pasadena, Calif.—National Treasurer W. I. Slichter, New York, N. Y. (re-elected).

These officers together with the hold-over officers will constitute the Board of Directors for the next administrative year, beginning August 1, 1936.

The annual report of the Board of Directors, presented at the meeting, showed a total membership on April 30, 1936, of 14,600.

Principal Equipment in Lakeside Station, Springfield, Ill.

BOILER

Boiler—Springfield Boiler Co. One 922 hp. cross drum with 2820 sq. ft. interdeck superheater and 1550 sq. ft. of water cooled walls. Furnace volume 7150 cu. ft.

Furnace Walls — Bigelow-Liptak Corp. Z Bar suspended tile construction.

Pulverizers—Riley Stoker Corp. Two 5 t. driven by Westinghouse 125 hp., 870 r.p.m. motors through Falk couplings. Feeders equipped with magnetic separators and driven by 1 hp. Westinghouse shunt wound d.c. motors with a speed range of 50 to 100 r.p.m.

Pulverized Coal Burners—Riley Stoker Corp. Two.

Oil Burner—The Engineer Co. One for standby service with interchangable tips for 24,000, 40,000 and 70,000 lb. of steam per hr.

Air Heater—The Superheater Co. One No. 340 horizontal type Ljungstrom, with 11,950 sq. ft. of heating surface and driven by a 3 hp., 1725 r.p.m. Westinghouse Type CS motor through a Falk 50 to 1 speed reducer.

Induced Draft Fan—American Blower Corp. One No. 9½, double width, double inlet, rated at 72,000 c.f.m. at 8½ in. static pressure at 422 deg. F. gas temperature and driven by a Westinghouse 150 hp., 700 r.p.m. motor through a Hydraulic Coupling No. 30 FD variable speed drive.

Forced Draft Fan—American Blower Corp. One, No. 5½ FH rated at 39,100 c.f.m. at 8½ in. static pressure, 100 deg. F. inlet air and driven by a 75 hp., 1760 r.p.m. Westinghouse motor through a Hydraulic Coupling No. 18 FD variable speed drive.

Combustion Control—Hagan Corp. One boiler panel and master control panel with provisions for extension to future boiler. Operating air supplied by Ingersoll-Rand 5 and 3 by 3½ in. 150 lb. compressor driven by a Westinghouse 5 hp., 1745 r.p.m. motor.

Boiler Feed Pumps—Allis-Chalmers Mfg. Co. Three type ML 5 centrifugals, each rated at 250 g.p.m. against a head of 1225 ft., 3520 r.p.m. Two driven by 125 hp. Westinghouse Elec. & Mfg. Co. motors, one by a Terry Steam Turbine Co. 120 hp. 450 lb. 25 lb. back pressure turbine.

Feed Water Regulator—Northern Equipment Co. Copes.

Differential Pressure Control—Northern Equipment Co. Copes, hydraulically operated.

Hand Feed Water Control Valves—Crane Co. No. 171 P.

Water Columns—Diamond Power Specialty Co. with inclined glass.

Non-Return Valve—Edward Valve & Mfg. Co.

Blow-Off Valves—Edward Valve Mfg. Co. Nos. 841 and 843.

Safety Valves—Crosby, Steam Gage & Valve Co. On drum.

Safety Valves — Consolidated Ashcroft Hancock. On superheater.

Motor Operated Valves—Crane Co. Two, type C9 on steam leads from boiler, and to turbine driven by a Westinghouse Type SK 3200 r.p.m. motor.

Fuel Oil Pump—Viking Pump Co. Size 15 g.p.m., driven by a Westinghouse 5 hp., 1750 r.p.m. motor.

Steam Traps—The Strong, Carlisle & Hammond Co.

Steam Separator—Cochrane Corp.

Piping—Power Piping Co.—welded with No. 1 Oxweld rod.

Welding Fittings—Crane Co.

Pipe Covering—Johns-Manville.

Hoist—Chisholm-Moore Hoist Corp. 3-t. driven by a 3 hp., 1610 r.p.m. motor located on the 7th floor.

Coal Handling System—Robins Conveying Belt Co. 75 t. per hr., consists of; a 30 in. apron feeder driven by a 3 hp. Westinghouse motor through a W. A. Jones 30 to 1 reducer; Conveyor A, a 24 in. rubber belt driven by a 5 hp. Westinghouse motor through a W. A. Jones 48 to 1 speed reducer and discharging over a Dings magnetic separator to a crusher; Conveyor B, a 24 in. rubber belt, driven by a 10 hp. Westinghouse, 1165 r.p.m. motor through a W. A. Jones 48 to 1 speed reducer, discharging through a distributor to the coal bunkers.

Coal Crusher—American Pulverizer Co. ring type, driven by a Westinghouse Elec. & Mfg. Co. 40 hp., 670 r.p.m. motor.

Coal Scales—Richardson Scale Co. Two, 200 lb. size equipped with Westinghouse 1725 r.p.m., ½ hp. motors.

Ash Sluice Pump—Allis-Chalmers Mfg. Co. One, 1000 g.p.m. against 225 ft. head driven by a 100 hp., 1765 r.p.m. Westinghouse motor.

Priming Ejector—Schutte & Koerting Co. for sluice water pump.

Ash Pumps—Allen-Sherman-Hoff Co. Two 750 g.p.m. against 14 ft. head, driven at 865 r.p.m. by a 75 hp. Westinghouse motor.

Sump Pump—Economy Pumping Machinery Corp., with a Valdon ½ hp. 1725 r.p.m. motor and a Square D float switch at track hopper.

Ash Piping—United Conveyor Corp.

TURBINE

Turbine—General Electric Co. One, 14-stage, 10,000 kw., 3600 r.p.m. for 450 lb. gage, 700 deg. F. steam. Generator rated at 12,500 kv-a., 13,000 v., 3 ph., 60 cycles, Direct connected, totally enclosed exciter.

Auxiliary Exciter—Westinghouse Elec. & Mfg. Co., 100 kw., 250 v. shunt wound type SK generator driven by an 8400 r.p.m., 450 lb. 25 lb. b.p. geared turbine.

Condenser—C. H. Wheeler Mfg. Co. Two-pass with a total cooling surface of 16,000 sq. ft., made up of 3884 tubes, ⅞ in. I.D. and 18 ft. long.

Traveling Screens—Link-Belt Co. Three 54 in., Model D, each driven at 6 r.p.m. by a Westinghouse 5 hp., 1750 r.p.m. motor through a Link Belt reducer.

Circulating Water Pump—Allis-Chalmers Mfg. Co. One, 24 x 24 in., type SD centrifugal with a capacity of 13,000 g.p.m. at 25 ft. Dual Driven at 500 r.p.m. by a Westinghouse 100 hp. motor or by a Terry Type ES 100 hp., 450 lb., 25 lb. b.p. 3125 r.p.m. geared turbine through a Cutler-Hammer magnetic clutch. Control arranged so that on the failure of power a Schutte & Koerting solenoid control will automatically start the turbine and energize the clutch.

Hotwell Pumps—C. H. Wheeler Mfg. Co. Two, type 3 centrifugals, each with a capacity of 240 g.p.m., 100 ft. head, Driven by 25 hp., 1750 r.p.m. Westinghouse motors.

Vacuum Pump—C. H. Wheeler Mfg. Co. Three 2-stage steam jets for operating steam at 350 lb. pressure, 364 deg. superheat. Capacity 350 lb. per hr., at 700 deg. F. 28.5 in. Hg.

Low Pressure Heater — Westinghouse Elec. & Mfg. Co. 450 sq. ft. designed for 125 lb. steam and water pressure.

High Pressure Heater — Westinghouse Elec. & Mfg. Co., 300 sq. ft., designed for 125 steam pressure, 600 lb. water pressure.

Deaerating Heater—Cochrane Corp. Size 150,000 lb. per hr., complete with a 91 sq. ft., 50 lb. steam and water pressure vent condenser.

Drip Coolers—Westinghouse Elec. & Mfg. Co. Two, designed for 125 lb. steam and water pressure, 100 sq. ft. of heating surface. One cooler on high pressure drip, one cooler on the evaporating drain.

Evaporators—Westinghouse Elec. & Mfg. Co. Double effect, designed for 100 lb. water, 150 lb. steam. Heating surface 150 sq. ft. in each effect.

Water Softener—The Permutit Co., Simplex Zeolite type with a capacity of 10,000 gal. of 6 gr. water, 10 hr. on evaporator feed.

Condensate Receiver—Worthington Pump & Machinery Corp., complete with 40 sq. ft. vent condenser and a 50 g.p.m., 152 ft. head centrifugal pump, driven by a 5 hp., 3450 r.p.m. Westinghouse motor.

Condensate Return Pump — Worthington Pump & Machinery Corp., 50 g.p.m. 152 ft. head, size 4, centrifugal, driven by a Westinghouse 7½ hp., 3475 r.p.m. totally enclosed motor.

Bleeder Non-Return Valves—Atwood & Morrill.

Atmospheric Exhaust Piping — Taylor Forge & Pipe Works.

Back Pressure Relief Valves—Atwood & Morrill.

Vacuum Breakers—Cochrane Corp.

Coppe Extension Joints—E. B. Badger & Sons Co.

Rubber Extension Joints—U. S. Rubber Co.

Condenser Air Meter—Elliott Co.

Priming Ejector—C. H. Wheeler Mfg. Co., steam jet.

Generator Air Cooler—General Electric Co., Type SF.

Generator Air Cooler—Schutte & Koerting Co., 64 sq. ft.

Centrifuge—De Laval Separator Co., size 50-60 g.p.m. driven by a General Electric ½ hp. single phase, 1780 r.p.m. motor.

Oil Transfer Pump—De Laval Steam Turbine Co., Type I M O, driven by a ½ hp. General Electric 1780 r.p.m., single phase motor.

Raw Water Make-up Valves—Kieley & Mueller, Inc.

Surge Tank Control—Kieley & Mueller, Inc.

Heater Drainers—Cochrane Corp.

Fire Extinguishers—Walter Kidde & Co., Inc. Fryout, portable and Lux CO_2 on generator.

Turbine Room Crane—Whiting Corp., 60 t.

INSTRUMENTS

Boiler Meter—Bailey Meter Co.

Boiler Water Level Recorder—Bailey Meter Co.

CO_2 Recorder—Hays Corp.

Flow Meter—Bailey Meter Co. On Feed Water Line.

Flow Meter—Cochrane Corp. On turbine steam and condensate.

Indicating Pressure Gages—Consolidated Ashcroft Hancock Co. On condenser.

Indicating Pressure Gages—Crosby Steam Gage & Valve Co. On control panels and feed water lines.

Indicating Thermometers—Taylor Instrument Cos. On control panels and feed water lines.

Lake Level Recorder—Cochrane Corp.

Multipoint Draft Gage—Hays Corp.

Recording Gages—Taylor Instrument Co. Temperature, pressure and vacuum on control panels.

Smoke Recorder—Bailey Meter Co. Galvatron.

Steam Pressure Recorder—Bailey Meter Co. On master boiler panel.

Surge Tank Level Indicators—Reliance Gage Column Co. On basement panel.

Water Meter—Hershey Mfg. Co. Compound type on house service.

Water Meter—Trident Mfg. Co. On soft water evaporator feed.

Vacuum Gage and Barometer—Taylor Instrument Cos. On turbine panel.

ELECTRICAL SYSTEM

Switchgear—Westinghouse Elec. & Mfg. Co. Six, Type O-22 A, 600 amp., 23,000 v. metal clad circuit breakers; potential transformers; lightning arresters; benchboard with miniature type instruments and Minatrol control; differential relays; Type HZ impedance relays; Type CRS ground relays; Type HD high speed current balance relays; watthour meter, totalizing and recording instruments; 8—440 v. totally enclosed auxiliary switchboard with Type AB Deion hinged with draw type circuit breakers.

Main Transformer—Moloney Electric Co. One, 12,500 kv-a., 3 ph., 13,200/23,000 v.

Auxiliary Transformer—Moloney Electric Co. Two, 1200 kv-a., 3 ph., 23,000/460 v.

Lighting Transformer—Moloney Electric Co. One, 100 kv-a.

Motor Generator Set—Westinghouse Elec. & Mfg. Co. Two, consisting of a 25 hp., 1750 r.p.m. Type CS motor driving a Type SK, 15 kw., 250 v. generator.

Battery Charger—Electric Products Co. Diverter Pole, 3 kw., 140 v., 1740 r.p.m. generator, driven by a General Electric 5 hp. motor.

Storage Battery — Philadelphia Storage Battery Co. Philco, steel glass type.

Voltage Regulators—Allis-Chalmers Mfg. Co.

MISCELLANEOUS

Air Compressor—Worthington Pump & Machinery Corp. Size 10x11, V-belted by Goodyear emerald cord drive to a Westinghouse 40 hp., 1150 r.p.m. motor.

Low Lift Pumps—Worthington Pump & Machinery Corp. Two, one rated at 3830 g.p.m., 50 ft. head and driven at 1160 r.p.m. by a Westinghouse 60 hp. motor. The other rated at 6250 g.p.m. 50 ft. head, driven at 860 r.p.m. by a Westinghouse 100 hp. motor.

High Head Pump No. 1—Dean Hill Pump Co. Capacity 4200 g.p.m., at 200 ft. head, driven at 1200 r.p.m. by an Allis-Chalmers 300 hp. synchronous motor.

High Head Pump No. 2—Worthington Pump & Machinery Corp. Capacity 6950 g.p.m. at 200 ft. head, driven at 1200 r.p.m. by a 450 hp. Electric Machinery Mfg. Co. 2300 v. synchronous motor.

High Head Pump No. 3—De Laval Steam Turbine Co. One, 10,500 g.p.m. at 200 ft. head, driven by a 618 hp. De Laval steam turbine with a C. H. Wheeler Mfg. Co. 600 sq. ft. waterworks type condenser.

CO_2 Scrubbers — Superior Machine & Boiler Works.

CO_2 Compressor—Sullivan Machinery Co. Capacity 301 c.f.m.

Heating Boiler—Kewanee Boiler Co., No. 760.

Valves, High and Low Service Water Lines—Crane Co.

Condensation Unit — Economy Pumping Machinery Corp. Condensate with the pump driven with a Brown-Brockmeyer, 5 hp., 3450 r.p.m. motor. This unit is for condensate return from the building heating system.

Check Valves—The Chapman Valve Mfg. Co. On "Tilting Disc" raw water pump discharges.

Regulating Check Valves—The Chapman Valve Mfg. Co. 'Cone type check valves on motor driven, high head pump discharges.

New Standards *for* Commercial Refrigerating Units

Introduction of small commercial condensing units in refrigeration field justify new standards for rating and testing.

By GLENN MUFFLY*

THIS NEW STANDARD Method of Rating and Testing Mechanical Condensing Units is complete in itself and I might hand it over to you without any explanation, but I would like to tell you why we needed it and how it is intended to be used. It has no application where compressors are sold separately from condensers, and the customer buys his motor from a different manufacturer. The engineer who specifies the equipment is in that case responsible for performance of the entire installation. He makes the necessary calculations and corrections from Standard Ton conditions, selecting a motor, a compressor and a condenser to fit the load.

When manufacturers began to build small refrigeration machines in large quantities, assembling the compressor, the motor and the condenser to a common base by production-line methods, these standard assemblies had to be given "over-all" ratings. It was no longer possible to let the customer select his own combination of units to fit the individual job. From this point on, the "unit" is an assembly of smaller units and we call it a "condensing unit" because it does the whole job of condensing the refrigerant.

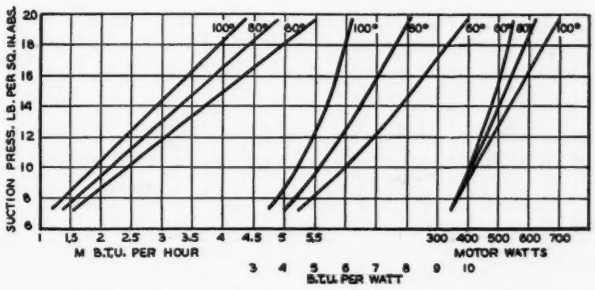
Now, a rating of this unit at 5 deg. F. (—15 deg. C.) and 86 deg. F. (+30 deg. C.) would be of no value to the customer who buys it, because he is not going to operate it at these temperatures, and could not if he wanted to. He will operate it at some evaporator temperature which fits his needs and the condensing temperature will depend upon the temperature of the condensing medium.

In its first meetings the committee agreed upon certain principles which were followed thereafter: In general we said that here is an assembly to be rated. The manufacturer has designed certain assemblies into it. He sells it as a package and it is to be rated for what it does as a whole. If it has excess condenser capacity and a motor of rather low efficiency it may equal the performance of another assembly which includes a less efficient condenser and a more efficient motor or compressor. The user pays for so much current to get a certain amount of refrigerating effect and we will rate the assembly on this over-all performance.

If one assembly regularly includes a heat exchanger between the refrigerant lines and another does not, these are the designers' options. Each unit shall be tested with whatever parts are "regularly furnished" by the manufacturers.

This is a "Standard Method," not a standard in the sense of setting any minimum efficiency that is acceptable. A buyer may compare the capacities and current inputs of competing machines under the conditions which apply to his usage. He is not interested in the separate efficiencies of various sub-assemblies such as motor, compressor or condenser unless he is planning to assemble a special condensing unit, which will then have to be tested as a whole before it can be given a rating under this Standard Method.

The buyer does not purchase a compressor, a condenser and a motor separately and mount them on his own base. He buys the complete assembly "A" or the complete assembly "B" after looking at their comparative capacities and prices and listening to the sales presentations of the two competitors.



Typical test results from a sulphur dioxide unit

No mention is made of units which include a gas or gasoline engine for driving the compressor, but the intent is that the power input shall in that case be measured in gallons of liquid fuel or cubic feet of gas fuel.

It is assumed that each manufacturer will show test data on his units at several room temperatures (if air cooled) or at several water temperatures (if water cooled), but only one room temperature is specified (90 deg. F.) and ingoing water temperature is held at 75 deg. F. for these four groups. The water temperature rise specified for test purposes is 10, 15 or 20 deg. F., according to group. Manufacturers may show test data for colder and for warmer ingoing water with various outgoing temperatures, but they must include data on tests made at these specified temperatures in order to make their figures comparable with those published by other manufacturers.

Water-cooled units are to be tested in a 90 deg. F. room temperature (ambient temperature) the same as air-cooled units. This is because water-cooled units are more or less cooled by air, particularly when the compressor is not water-jacketed or when the refrigerant is condensed in an exposed or partially exposed shell.

*General chairman of a joint committee sponsored by the A.S.R.E. and participated in by the N.E.M.A., R.M.A., A.C.M.A. and A.S.H. & V.E. This is an abstract of an address made in presenting the New Standard to the industry. Copies of the Standard may be obtained for 15 cts. from the A.S.R.E., 37 W. 39th St., New York City.

Flue Gas Weights Calculated

By means of analyses of coals, oil and gases with the aid of tables, charts and formulas, the weights of flue gases to be handled can readily be calculated for various rates of combustion

FREQUENTLY in combustion calculations it is necessary to know the number of pounds of flue gas to be handled per hour, and the mean average specific heat of these products of combustion.

In many cases an analysis of the fuel is not given, and quite often, when there is some sort of an analysis, it is merely proximate analysis, which is of no aid in figuring the number of pounds of air required per pound of fuel.

In cases like this a time-honored rule-of-thumb method of calculation has allowed 7.65 lb. air per 10,000 B.t.u. in the fuel as the amount theoretically required with no excess air. This was supposed to apply to both oil and coal firing, but as the amount of excess air for a given percentage of CO_2 varies considerably with different fuels, the figure of 7.65 lb. is a very approximate method of calculation, and is true only in certain cases. Let us pick at random samples of the following fuels:

ULTIMATE ANALYSIS "AS FIRED"

	Kentucky Coal	Ill. Coal	N. Dak. Lignite	W. Va. Coal	Fuel Oil	Ref. Gas	Nat. Gas
Carbon	69.78	68.45	41.87	84.11	84.0	77.6	82.5
Hydrogen	5.49	5.10	6.93	5.01	12.7	19.0	17.5
Oxygen	14.40	16.29	44.94	5.89	1.2	0.6	...
Nitrogen	1.37	1.14	0.69	1.56	1.7	2.8	...
Sulphur	1.35	0.90	0.48	0.64	0.4	...	...
Ash	7.61	8.12	5.09	2.79	...	...	...
B.t.u.	12,874	12,015	7,204	14,760	18,700	22,100	21,340
Moisture	6.9	9.18	36.78	3.22	...	...	...

According to the commonly accepted equation: Lb. air per lb. fuel = 11.52 C + 34.56 (H — 0/8) + 4.32 S, we have the following:

	Ky.	Ill.	Lig.	W. Va.	Oil	Ref. Gas	Nat. Gas
Lb. air per lb. fuel	9.39	8.96	5.27	11.09	14.03	15.5	15.6
Lb. air per 10,000 B.t.u.	7.30	7.45	7.32	7.50	7.50	7.01	7.30

The average is 7.34 lb. air per 10,000 B.t.u. with no excess air instead of 7.65 in. Also the weight of flue gas per 10,000 B.t.u. will vary considerably, depending on the amount of ash in the fuel and the carbon in the refuse.

Tables Show Performance of Representative Fuels

To facilitate calculations, analyses representative of various classes of fuels have been selected, and on the basis of these analyses Tables I to V have been prepared. These tables show respectively per cent CO_2, per cent excess air, pounds of air per pound of fuel, pounds of gas per pound of fuel, mean specific heat of the gas, pounds of water vapor per pound of fuel, and the latent and sensible heat in the vapor.

Pounds of gas for each percentage of CO_2 is the total amount of gas per pound of fuel, and includes both dry gases and water vapor. The values of mean specific heat are calculated for the mixture of dry gases and water vapor between 250 and 800 deg.

Amount of water vapor per pound of fuel is dependent, of course, on the amount of available hydrogen and the moisture in the fuel. For any given fuel this is constant for any percentage of CO_2. This item is given in each table as a matter of interest, and to show the effect of water vapor on the specific heat. The last item in each table is the B.t.u. of sensible and latent heat of the water vapor. This is given to facilitate heat balance calculations.

As an example of such calculation, referring to Table I, we find that for 14 per cent CO_2, 16.4 lb. flue gas are produced per pound of oil. The mean average specific heat is 0.2571 B.t.u. To find the total B.t.u. lost up the stack at, say, 550 deg. F., and with air at 80 deg. F., the following equation would be used:

Stack loss in B.t.u. = $[16.5 \times 0.2571 \times (550 - 80)] + 1255$. In each table the sensible and latent heat of water vapor is figured for air at 80 deg. F.

Supplementary to each table, curves in Figs. 1 to 5 respectively have been prepared to calculate efficiencies, or, reversing the process, to assist in determining the number of pounds of gas per pound of fuel.

How to Use the Tables

For example, supposing a proposition were submitted stating that Illinois coal of 11,000 B.t.u. as fired was to be burned at 70 per cent efficiency with a flue gas temperature of 550 deg. F., air at 80 deg. F. The maximum load was to be 1200 hp. per hour.

The first step would be to find the number of pounds of coal required per horsepower. By the equation:

$$\text{Lb. coal per hp.} = \frac{33500}{\text{B.t.u.} \times \text{Efficiency}}$$

we find that $\frac{33500}{1100 \times .70} = 4.35$ lb. coal per b.hp.

If the amount of carbon in the refuse is not stated, it is safe to assume an average figure of 25 per cent. Since Illinois coal is classed as mid-western bituminous, we may now refer to Fig. 4, which shows curves of efficiencies for this class of coals. These efficiencies are gross values, and to obtain net values the per cent

From Fuel Analyses

By J. R. DARNELL

Consulting Engineer
Jenkins Petroleum Process Co.

loss due to carbon in the refuse must be subtracted from curve value. Referring to the lower curve we find that 25 per cent carbon in the refuse gives a loss of 4.85 per cent. Adding this to 70.0 per cent we get 74.85 per cent gross efficiency. Starting at 74.85 per cent efficiency we go straight down until we strike the 550 deg. line, and then extend a horizontal line to the CO_2 excess air curve. From this point, going down to the CO_2 base line, we find that 10.1 per cent CO_2 or 82 per cent excess air must be found in the flue gas in order to produce this efficiency. Interpolating in Table IV, or more exactly, from the curve for Illinois coal in Fig. 8 we find that 12.9 lb. gas are produced per pound of coal. Since 4.35 lb. coal are burned per boiler horsepower, there will be 4.35×12.9 or 56 lb. gas per boiler horsepower. Then, $56 \times 1200 = 67{,}250$ lb. gas per hour.

Curves Show Weight of Gas Per Cubic Foot

Besides the weight of gas per hour it is necessary to know the number of cubic feet per minute, in order to determine fan capacity. This is done by dividing the weight of gas per minute by the weight of one cubic foot of gas. In each of Tables I to V the last item gives the weight of one cubic foot of gas at 65 deg. F. for varying percentages of CO_2. For any percentage of excess air corresponding to a given CO_2 value, the exact weight of one cubic foot of gas may be found from the curves in Fig. 9. In the above cases there are $\frac{67250}{60}$

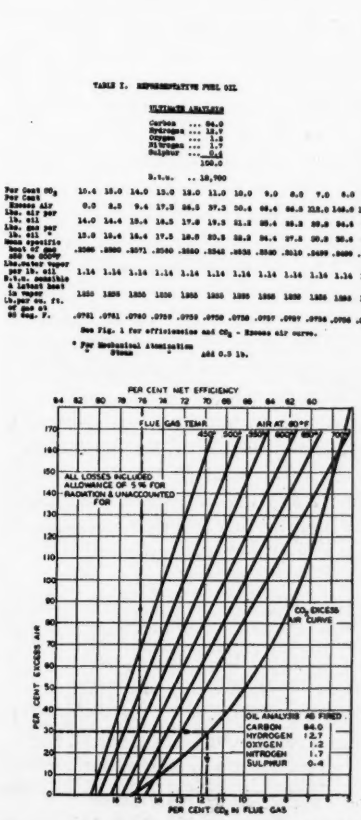


Fig. 1. Representative fuel oil combustion characteristics

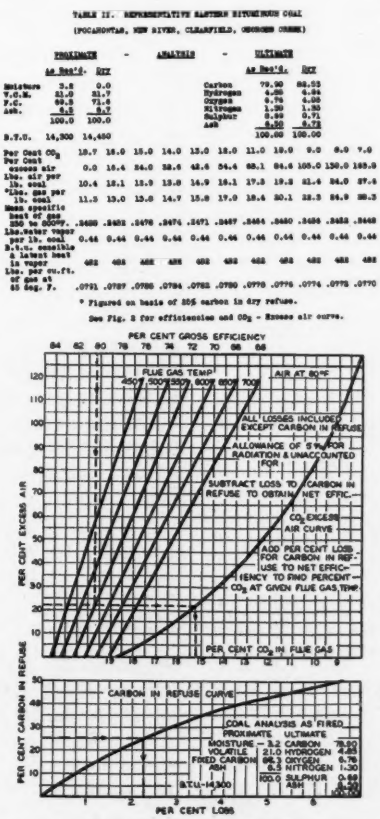

PER CENT GROSS EFFICIENCY
FLUE GAS TEMP.
AIR AT 80°F
ALL LOSSES INCLUDED EXCEPT CARBON IN REFUSE
ALLOWANCE OF 5 % FOR RADIATION & UNACCOUNTED FOR
SUBTRACT LOSS TO CARBON IN REFUSE TO OBTAIN NET EFFIC.
CO₂ EXCESS AIR CURVE
ADD PER CENT LOSS FOR CARBON IN REFUSE TO NET EFFICIENCY TO FIND PERCENT CO₂ AT GIVEN FLUE GAS TEMP.
PER CENT EXCESS AIR
PER CENT CO₂ IN FLUE GAS
CARBON IN REFUSE CURVE
COAL ANALYSIS AS FIRED
PROXIMATE
MOISTURE 3.2
VOLATILE 31.0
FIXED CARBON 58.3
ASH 7.5
B.T.U. 14,300
ULTIMATE
CARBON 79.50
HYDROGEN 4.85
OXYGEN 6.75
NITROGEN 1.30
SULPHUR 0.60
ASH 7.50
100.0
PER CENT CARBON IN REFUSE
PER CENT LOSS

Fig. 2. Characteristic combustion curves for representative eastern bituminous coals

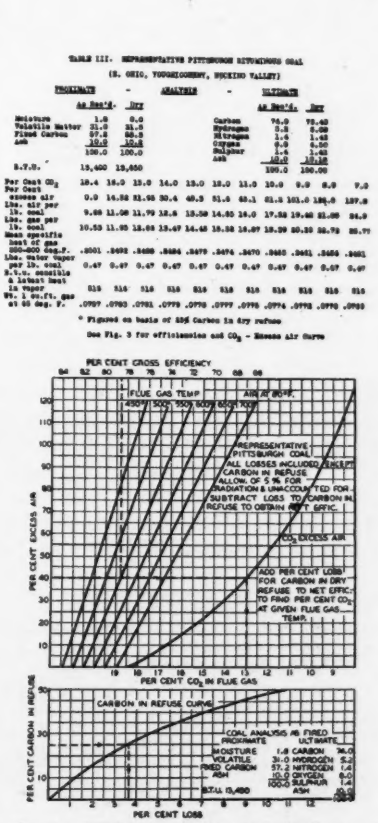
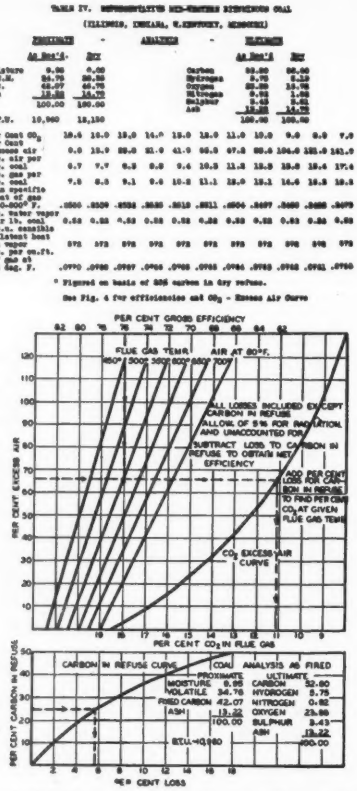
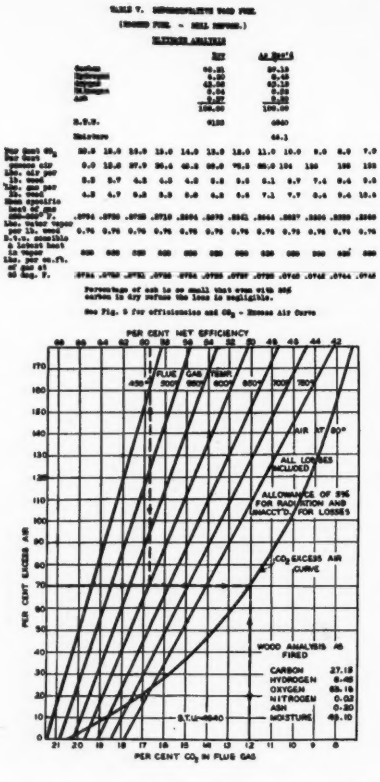
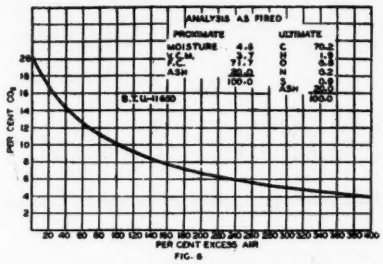

PER CENT GROSS EFFICIENCY
FLUE GAS TEMP.
AIR AT 80°F
REPRESENTATIVE PITTSBURGH COAL
ALL LOSSES INCLUDED EXCEPT CARBON IN REFUSE
ALLOW. OF 5 % FOR RADIATION & UNACCOUNTED FOR
SUBTRACT LOSS TO CARBON IN REFUSE TO OBTAIN NET EFFIC.
CO₂ EXCESS AIR
ADD PER CENT LOSS FOR CARBON IN DRY REFUSE TO NET EFFIC. TO FIND PER CENT CO₂ AT GIVEN FLUE GAS TEMP.
PER CENT EXCESS AIR
PER CENT CO₂ IN FLUE GAS
CARBON IN REFUSE CURVE
COAL ANALYSIS AS FIRED
PROXIMATE
MOISTURE 1.8
VOLATILE 34.0
FIXED CARBON 57.2
ASH 7.0
B.T.U. 13,480
ULTIMATE
CARBON 76.0
HYDROGEN 5.0
NITROGEN 1.4
OXYGEN 6.0
SULPHUR 1.4
ASH 10.2
100.0
PER CENT CARBON IN REFUSE
PER CENT LOSS

Fig. 3. Combustion characteristics for representative Pittsburgh coal







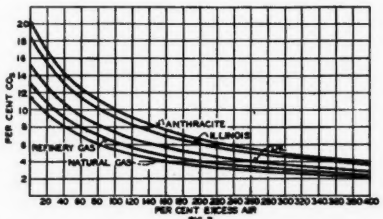


Fig. 4. Representative mid-western bituminous coal combustion characteristics

Fig. 5. Combustion characteristics of representative wood fuel

Fig. 6. CO_2—Excess air relationship with rice anthracite

Fig. 7. CO_2—Excess air curves for representative fuels

or 1120 lb. gas per minute. From the curve for Illinois coal in Fig. 4, we find that for 10.1 per cent CO_2, corresponding to 82 per cent excess air, the weight of gas at 65 deg. is 0.0763 lb. per cu. ft. Then,

$$\frac{1120}{0.0763} = 14{,}690 \text{ cu. ft. per min.}$$

Method of Calculation from an Ultimate Analysis

If an ultimate analysis of any solid or liquid fuel is given, the CO_2—excess air relation may be calculated as follows. First determine the maximum CO_2 by the formula:

$$M = \frac{20.9}{1 + \frac{(2.38\,[H - 0/8])}{(C + 0.375)}}$$

The excess air for any given per cent of CO_2 may then be determined by the formula:

$$E = \frac{(CO_2 \text{ max.} - \text{actual } CO_2)\ 0.791}{\text{Actual } CO_2\ (100 - CO_2 \text{ max.})}$$

If the maximum CO_2 is known, and it is desired to determine the amount of oxygen present in the flue gas at any given per cent of CO_2, this may be found by the formula:

$$O_2 = \frac{20.9\ (M - \text{actual } CO_2)}{M}$$

This, of course, assumes complete combustion with no CO present.

As previously stated, the pounds of air theoretically required with no excess may be found by the formula: Lb. air at maximum $CO_2 = 11.52\ C_a + 34.56\ (H - 0/8) + 4.32\ S$. Where H, O, and S are the percentages by weight respectively of hydrogen, oxygen and sulphur in 1 lb. of fuel, C_a is the per cent of carbon, by weight, in 1 lb. of fuel which is actually burned. This is obtained by subtracting from the ultimate carbon given in the analysis the amount of carbon in the refuse, calculated as per cent of 1 lb. of coal.

In the case of the eastern bituminous coal given in Table II, if there is 25 per cent carbon in the dry refuse and 6.72 per cent dry ash in the coal, then $1.00 - 0.25 = 75$ per cent ash in the refuse, and $1.00/0.75 = 1.33$ per cent refuse for each 1 per cent ash in the coal. With 6.72 per cent ash in dry coal, $6.72 \times$

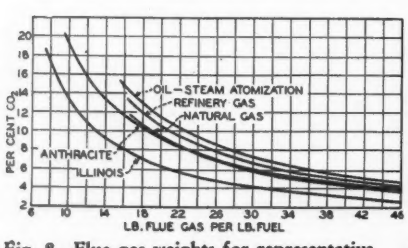


Fig. 8. Flue gas weights for representative fuels

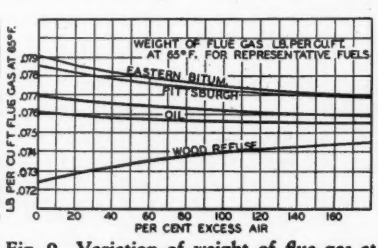


Fig. 9. Variation of weight of flue gas at 65 deg. F. with excess air for representative fuels

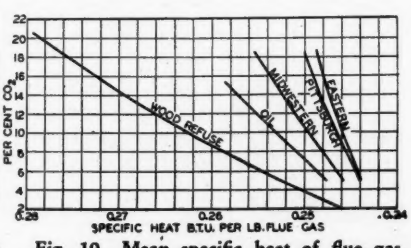


Fig. 10. Mean specific heat of flue gas, 250 to 800 deg. F. for representative fuels

1.33 = 8.95 per cent refuse and the weight of carbon in the refuse as a fraction of a pound of dry coal is 0.0895 × 0.25 or 0.0224 lb. carbon. Since there is 3.2 per cent moisture in the coal as fired, there is 2.24 × 0.968 = 2.17 per cent of each pound of coal found in the ash pit.

The amount of carbon actually burned then will be 79.9 — 2.17 or 77.73 per cent of 1 lb. of coal as fired. This will be the value of C_a in the above equation. After calculating the amount of air required for any percentage of CO_2, the amount of gas produced is obtained by adding to the weight of air per pound of coal fired, that per cent of 1 lb. of coal which actually passes up the flue. This is found by subtracting from 100 per cent the per cent of ash in the coal plus the per cent of 1 lb. of coal found in the refuse. In this case there is 6.50 + 2.17 = 8.67 per cent left behind, or 100.00 — 8.67 = 91.3 per cent of each pound of fuel as fired passes up the stack. Accordingly, 0.91 lb. must be added to the weights of air per lb. of fuel to obtain the amount of gas per pound of fuel.

The following shows the method of calculating the values of mean specific heat and the weight of gas per cubic foot in the case of eastern bituminous coal:

Carbon burning to CO_2 requires 2.67 lb. oxygen

Hydrogen burning to H_2O requires 8.0 lb. oxygen

Sulphur burning to SO_2 requires 1.0 lb. oxygen

Then:

0.777 × 2.67 = 2.08 lb. O_2, 2.08 + 0.777 = 2.857 lb. CO_2.
0.0485 × 8.0 = 0.388 lb. O_2, 0.388 + 0.0485 = 0.437 lb. H_2O.
0.0069 × 1.0 = 0.007 lb. O_2, 0.007 + 0.007 = 0.014 lb. SO_2.

Total	2.475 lb. O_2
Minus	0.068 lb. O_2 in the coal
	2.407 lb. O_2 supplied per lb. coal.

Since there is 1 lb. of oxygen in each 4.32 lb. air, then: 2.407 × 4.32 = 10.41 lb. air theoretically required at maximum CO_2 with no excess air. (Note that this method checks with the formula previously given for figuring the amount of air required.)

For maximum CO_2 there is, of course, no oxygen in the flue gas and the weights of the products of combustion are:

	Weight of Products, Pounds	Per Cent by Weight	#Mean Sp. Heat 1 lb. of each gas		Mean Sp. Heat of constituents
[x]CO_2	2.871	0.253	× 0.2185	=	0.0554
H_2O	.437	0.039	× 0.4630	=	0.0181
N_2	8.022	0.708	× 0.248	=	0.1753
Total	11.330	1.000			0.2488 B.t.u.

[x]Includes SO_2 # Values of mean specific heat for each gas are averages between 250 and 800 deg. F. taken from curves given in Helios, 27th Edition, pp. 403-405. See also p. 32, Fig. 1, Principles of Combustion by A. D. Pratt.

At percentages of CO_2 less than maximum, oxygen appears in the flue gas along with the nitrogen. At any percentage of CO_2 the weight of oxygen is calculated as follows:

At 13 per cent CO_2, as shown in Table II, there is 42.6 per cent excess air. Then, since the oxygen and nitrogen in the air are 23.15 and 76.85 per cent by weight respectively:

$$10.41 \times 0.426 \times 0.2315 = 1.03 \text{ lb. } O_2$$
$$10.41 \times 0.426 \times 0.7685 = 3.41 \text{ lb. } N_2$$

	Weight of Products, Pounds	Per Cent by Weight	Mean Sp. Heat of 1 lb. of each gas		Mean Sp. Heat of constituents
CO_2	2.871	0.182	× 0.2185	=	0.0398
H_2O	0.437	0.028	× 0.4630	=	0.0130
O_2	1.030	0.065	× 0.2200	=	0.0143
N_2	11.432	0.725	× 0.2480	=	0.1800
Total	15.770				0.2471 B.t.u.

Values of mean specific heat at various percentages of CO_2 for different fuels are shown in Fig. 10.

The weight of one cu. ft. of flue gas for 13 per cent CO_2 in the case of eastern bituminous coal, as shown in Table II, is calculated thus:

Per Cent by Weight		Weight 1 cu. ft. of each gas at 60° F.		Cu. ft. of constituents at 60° F.
CO_2 0.1809	+	0.1164	=	1.550
H_2O 0.0278	+	0.0476	=	0.584
O_2 0.0664	+	0.0846	=	0.784
N_2 0.7249	+	0.0743	=	9.750
1.0000				12.668 cu. ft. per lb. of gas

$$\frac{1}{12.668} = 0.0789 \text{ lb. per cu. ft. at 60 deg. F.}$$

$$0.0789 \times \frac{520}{525} = 0.0781 \text{ lb. per cu. ft. at 65 deg. F.}$$

Values of flue gas weight in pounds per cubic foot at various percentages of CO_2 for different fuels are shown in Fig. 9.

Longest Pipe Line to Furnish Gas at Detroit

THE LONGEST WELDED steel pipe line in the country, totaling 1152 miles, will serve Detroit, Mich., with natural gas from the Texas gas field district. The line will reach from Amarillo, Tex., to the municipal limits of Detroit and is scheduled for completion this summer. The Panhandle Eastern Pipe Line Co., Kansas City, Mo., affiliated with the Columbia Gas & Electric Corporation, New York, is now operating a steel pipe line for natural gas transmission from Amarillo to Dana, Ind., 867 miles; from this point an extension has been made to Zionsville, Ind., about 55 miles, and work is now nearing completion on the welded steel pipe line from latter point to Detroit, 230 miles, consisting of 22-in., seamless steel pipe, furnished by the National Tube Co., Pittsburgh, Pa. The Michigan Gas Transmission Corporation, Detroit, has been organized as a subsidiary of the Columbia, to operate the new section of line, and will make delivery to the Detroit City Gas Co., Detroit, on a basis of 90,000,000 cu. ft. per day; the latter utility will utilize for local distribution, and is constructing a terminal mixing and distributing plant, with local pipe lines for connection with present system in the metropolitan area. Compressor stations for booster service are being installed at points along the new Zionsville-Detroit line, for which 12-1300-hp. and two 1000 hp., twin-tandem type gas-driven compressor units with accessory equipment are being furnished by the Cooper-Bessemer Corp., Mount Vernon, Ohio, as well as six 200 hp. vertical gas engine-driven electric generator units and auxiliaries for compressor station service. The entire project will represent an investment of about $16,000,000. Natural gas will be available for Indianapolis, Ind., from the pipe line section between Dana and Zionsville, noted, this part of the route being under the direction of the Indiana Gas Transmission Corporation, Indianapolis, another subsidiary interest.

IN MANUFACTURING cement 158 lb. of coal are required for each 376-lb. barrel of cement.

Research Trends *in the* Power Industry

A Few of the Things That Are Engaging the Time and Efforts of Those Entrusted with Improving Equipment and Practice.

By C. F. Hirshfeld, The Detroit Edison Co.

THOSE OF US who are employed in the power industry are apt to be so steeped in it that we fail to see it in perspective. It is, and we are of it, and we go about our daily work without giving much thought to anything but the job of the minute and occasionally of the jobs we anticipate for the next few minutes. Let us take just one look at this thing in perspective. A view of the past frequently assists the interpretation of the present and the appraisal of the future.

Man has rather suddenly come to realize that his very existence is today bound up with the availability of power. He appreciates that the line of progress and its rate are determined by the rate and extent to which power can be made available in ever increasing quantities. With this realization has come a rather sudden and panicky type of fear. What is going to happen to that nation which does not now have or cannot maintain adequate power supplies? What is going to happen to the whole race if such power supplies cannot be maintained?

I cannot become excited over the future of the world power supply or of our national power supply. With respect to our own country we have resources for producing power by present methods and at the present rate for many thousands of years. Even if you choose to assume an ever increasing utilization of power, which is probably reasonable, the estimated time to exhaustion is still so great that I see no reason for worrying about it. When one realizes the changes that have occurred and the advances that have been made in this field in a short fifty years, it seems hardly reasonable to assume we shall be dependent on the same methods of power production or even on fuel or water for power production a few thousand years hence.

I have said our problem is to make power as available, cheap and reliable as we can within certain rather broad limitations. I am becoming more and more impressed with the fact that we have gone much further in these directions technically than we have economically. It seems to me the time has arrived when those working in the power field must undertake far reaching and non-partisan economic investigations of a high order. The engineer may feel that endeavor of these sorts is none of his business. I cannot see things in that way. Let us suppose for a minute that the doctors of medicine produced and used widely some sort of treatment which a few years later resulted in a widespread physiological or psychical breakdown of some sort. You would undoubtedly expect the medical profession to recognize its responsibilities and to start post haste upon a solution and a cure.

We, as engineers, have produced something which is now wrenching in no unmistakable fashion the social and economic life of the world. Is it reasonable to assume we should shrug responsibility from our shoulders, wash our hands of all consequences and proceed to the production of still more disturbing devices? Should we not rather pitch in and assist in the interpretation of our works and the appraisal of their consequences? To my mind the end result would be better if we could expend our efforts entirely in such directions for the next decade. We might thus assist in stabilizing society and bringing it to a position where it would be either safe or at least more safe for us to proceed with technical development.

Few of us are equipped to assist in this sort of work and still fewer are capable of making such analyses themselves. The vast majority undoubtedly will continue to improve the technic of power production, distribution and utilization, come what may. That which follows in this paper is intended for this vast majority. The outstanding development in steam power generation during the past few years has been the increase of both steam pressure and steam temperature. Steam pressures of the order of 1200 to 1400 lb. are now almost commonplace and steam temperatures of 850 to 950 deg. F. are no longer regarded as excessive. These pressures and temperatures have been made possible by the results of extensive research and they still present many problems to the research engineer.

It is of interest to note that the tendency of the day is away from reheating. This places a premium on high steam temperature. In fact, the present advanced practice is to use the highest steam pressure which can be used with the highest steam temperature deemed practicable without producing excessively wet steam at the turbine exhaust. But, there is still a great opportunity for the metallurgist and the turbine builder. We need cheap materials which can be used for the blades in the wetted rows or materials which can be more easily and safely attached to protect these blades from wastage. The more common use of high pressures and temperatures is also focusing attention

*From a paper presented before the Midwest Power Engineering Conference.

upon the control of the character of water in the boiler. Great progress has been made in feedwater treatment and in the control of the material within the boiler, but much remains to be done. Some years ago we thought we had solved completely the phenomena of caustic embrittlement. Now we have doubts. Recent research appears to indicate the matter is not quite so simple as we had believed. It now appears, for example, that for the production of embrittlement the presence of silica is necessary in addition to the caustic. Problems of scaling in high pressure boilers have not been solved completely. Further research is needed here, particularly with reference to cases involving large proportions of make-up water. The increasing severity of use of metal makes very small deposits tremendously significant.

Boiler corrosion has always been with us. For the lower pressures the problem is fairly well solved. For the higher pressures this cannot yet be said to be true. New forms of attack make their appearance and present some puzzling problems. In this connection much useful information is expected from research now in progress at Purdue and to a limited extent elsewhere. This has for its object a study of the attack of high pressure and high temperature steam, with and without admixed gas, upon steels of different types throughout a wide range of temperatures.

In this country we have confined ourselves almost entirely to modification of old boiler forms in our production of steam generators for increasingly higher pressures. In Europe there has been a greater tendency toward technical analysis of the new problems presented and a resultant production of new and, in some cases, radical forms. This tendency is just now becoming evident on this side of the water. Here is a field worthy of the best efforts of research engineers. The objective should be adaptation to high pressures and temperatures, and high rates of output, minimum sensitivity to the character of the water used, low first cost and low maintenance cost and a very high degree of availability, combined with ready adaptability to the maximum possible range of fuels. There is some reason for believing that forced circulation designs may figure prominently among the new types.

Probably the largest and most difficult task facing us in connection with steam generation is the treatment of effluent products of combustion. It is true that we now possess reasonably satisfactory means for the suppression of smoke and for the elimination of solid particles from the gases discharged from the stacks of large plants. But, we are faced with another problem not so easy of solution. This is the elimination of sulphur products from the effluent gases. You are all undoubtedly familiar with the monumental equipment installed for this purpose in the Battersea plant in London. This hardly can be considered a satisfactory solution. The power world waits for that genius who shall salvage the sulphur with inexpensive equipment and return it as a saleable by-product in some form without producing some other product which is difficult or costly to dispose of.

Advent of high steam temperatures has served to focus attention upon the increasing hazard presented by the use of inflammable lubricating oil. This has resulted in radical changes in both the location and the construction of oil containing parts and pipes for the purpose of minimizing the possibility of spilling oil onto hot steam pipe covering. It has also led to the development of a sprinkler system well adapted to quench instead of to spread an oil fire. It has also served to focus attention on the need for non-inflammable lubricants. This is at present a rich field for research.

Nor has the lowly condenser been ignored in this march toward better things. It cannot yet be said that we know the complete theory of condenser performance but we are a lot nearer that goal than we were a few years ago. Presumably we shall continue toward this goal. In this connection, one very interesting research may be mentioned. It has been discovered that condensation may occur in two different ways. One results in the formation of a liquid film over the condensing surface; the other results in the formation of drops which run off the surface as such. One is much less effective in the use of surface than the other. It is not yet known whether conditions can be sufficiently well controlled in practice to eliminate the less efficient and to produce the more efficient type of condensation. There is at least some promise that they can, both in steam condensers and in other equipment of similar type used in chemical and other industries.

Rehabilitation of old plants, both utility and isolated, is now a very live subject. Many methods are available and local conditions naturally determine the choice that should be made. However, there is one method which is coming into prominence and which possesses many advantages in situations adapted to its use. This is known as superposition and consists of the installation of high pressure steam generators together with high pressure prime movers exhausting into the old low pressure system. In a rough way this generally results in a considerable increase of capacity at a moderate cost, combined with a remarkable increase of overall thermal efficiency.

Another rich field of research may be described as directed at the partial supersession of the conventional type of rotating equipment. Practically all engineers are more or less familiar with various electronic developments; they are familiar with the use of tubes for producing old results previously achieved by rotating equipment or new results not previously attainable. Probably very few know of more or less successful efforts toward the development of electrostatic systems. It is a fact that electrostatic generators of large capacity are well advanced in the experimental stage and that electrostatic motors have been constructed and operated successfully. Some limited publicity has been given recently to a semi-commercial method of direct current transmission developed by one of the large electrical manufacturers.

What all this may portend no one can yet say. It has at least the appearance of being about to produce radical change from the electrical systems we have known from the beginning of the industry. The problems to be solved are still formidable but there is no reason for assuming them insurmountable. It should be remembered that it is only a few years since some of our best electrical engineers shelved the mercury arc rectifier as an impossible contraption from the

commercial aspect. But the same men lived to take it off the shelf again and to make a commercial success of it.

Any review of the trends of research in the power industry would be incomplete without reference to the phenomenal progress of the Diesel engine. This has resulted to a great degree from intensive research, partly metallurgical, partly chemical, partly thermodynamic and partly in the field of applied mechanics. It has taken all this and more to convert a very interesting and partly developed suggestion into the commercially useable device of today.

There is another set of possibilities that appears to be ripe for investigation. Before the advent of low superheats and high vacuums in steam plants much study was given to binary vapor cycles as a means of increasing thermal efficiency. They always proved unuseable commercially because of the high first cost of the necessary equipment. More recently a binary vapor cycle using mercury and water has achieved a measure of commercial success. It is at least possible that there may be other combinations capable of yielding commercially useable plants of still higher thermal efficiency. The fact that the field was so thoroughly investigated years ago should not be taken as evidence that the advances made during the past twenty years have not opened up new and worth while possibilities.

In the field of water power little is to be expected in the form of higher efficiency except possibly at fractional loads or under variable heads, but this does not mean there are not many opportunities for profitable research. The subject of cavitation is just now being studied exhaustively and many new factors and facts are being brought to light. Undoubtedly these will be reflected in lessened maintenance or longer life. Undoubtedly also they will be reflected in better pump performance.

There are always those who insist on knowing what we are going to do for power when we have exhausted our fuel supplies and find our hydraulic supplies inadequate to our needs. I have indicated already that I do not see any need for worrying now about that very distant situation. But if one must speculate as to the future or actually attempt to solve these problems for our distant descendants there are many interesting lines of attack. These may be divided roughly into four groups, three of which may be found to be very closely allied when we know more about them.

First we have the possibility of utilizing in some way the energy reaching us from the sun if that body be still disgorging energy when the time arrives. Thus far we have confined our activities almost entirely to the utilization of stored solar energy. In that distant day of which we are now speculating it must be more of a catch and carry proposition.

It is well known that certain thermal plants utilizing the sun's rays have been constructed and are in use in different parts of the world. They do not give much promise as the ultimate solution because of the tremendous size in comparison with output. It would seem far more sensible to utilize some photo-electric or photo-chemical effect. Nature succeeded in doing the latter in the case of plants and there does not seem to be any reason for assuming that man cannot devise and perfect a somewhat similar process for power production. If this task seems formidable it might be well to remember that it is only a few generations since man made synthetically the first organic compound. These were supposed to be among Nature's greatest mysteries and producible only through the action of living matter. And then an ambitious chemist produced urea and broke the tradition. Since then man has produced thousands of organic compounds previously so unalterably Nature's prerogative and, more, he has produced many that Dame Nature never appears to have bothered with. Is there any reason for thinking he will not be able to devise means of converting by new chemical processes the flow of solar energy into more directly useable forms when the necessity arrives? I think not.

But, the pessimist may still question whether even if this can be done, the receipt of solar energy will be sufficient to supply the need. No one can say. But we can say that the present rate of receipts is so great that we cannot now imagine man requiring as much power as could be produced therefrom even by very inefficient means.

Second, we have the possibility of utilizing the heat of the earth itself. If we are to believe our astronomers this is a form of stored solar energy. As no one has any real knowledge of what the core of the earth consists of or what its temperature is we can do little along this line of speculation. We do know that deep shafts and deep borings indicate a fairly regular increase of temperature and that there are other evidences of very high internal temperatures.

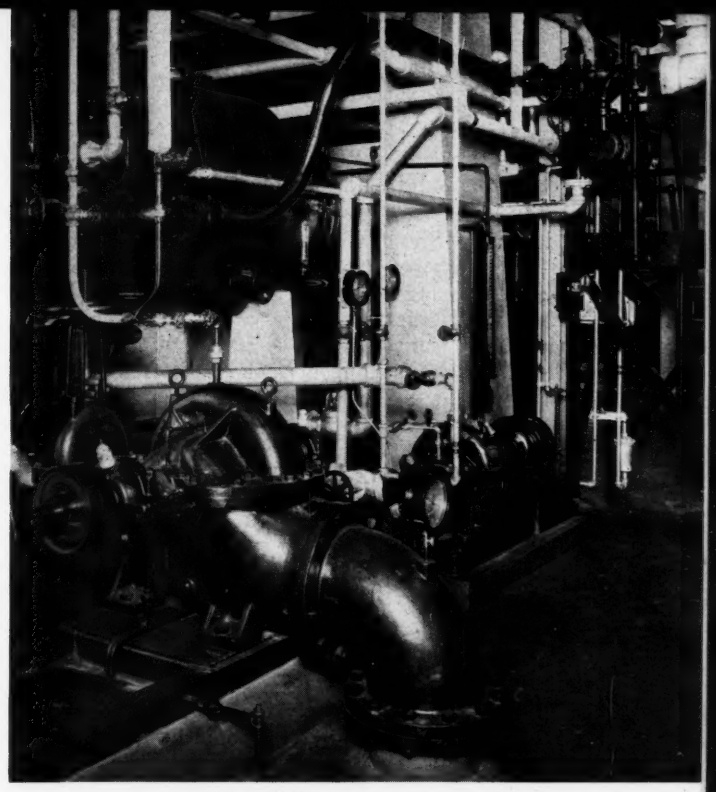
One might question the sufficiency of this stored energy. One might fear it would be too quickly exhausted. Here also argument is impossible because we have insufficient information. However, if we use what has been surmised as the basis of calculations we run quickly into figures of astronomical magnitude.

Third, there is the possibility of harnessing the world's thunderstorms. One of our early scientists indicated very crudely one way in which this might be done. It has been estimated that the world's thunderstorms represent a continuous supply of about 10,000,000,000 kilowatts. This is woefully small when compared to the flow of solar energy but still represents a respectably large amount of power.

Fourth, there is the oft suggested scheme of tapping atomic energy. At present we have not the slightest idea of how this might be done. In so far as I know, all our findings to date rather negative the possibility. But, we must remember there was a time when man did not even know how to kindle a fire. There may be latent possibilities of energy release that we do not now suspect.

At any rate, whether we are inclined to worry about the distant future or whether we prefer to leave that to our descendants, there is quite enough research to be done in meeting present needs to busy all the men who have thus far adopted this walk of life and all those we can imagine adopting it. The problem is not one of finding worth while things to do but of persuading those who hold the purse strings that, in a financial sense, they are worth doing. Happily experience is making this daily so much more evident that even this problem appears to be nearing solution.

Operating *the* Turbine Auxiliaries



By PAUL F. ROGERS

WHEN IT COMES to preparing operating codes the engineer is up against a difficult proposition and must depend to a large extent on his experience for all the details although the general procedure for a given piece of equipment can be outlined and form the basis of a workable detailed code. It is surprising how many good engineers know how to do things but find themselves completely at sea when it comes to writing down detailed directions for others unless they have a pattern to follow.

Operating codes* published so far are complete for the boiler room, but a noncondensing turbine plant needs are too limited to have a code for a plant of this type of much value to the engineer with a condensing turbine, motor and turbine driven auxiliaries, hotwell, circulating vacuum, and auxiliary oil pumps to say nothing of instruments which should not be forgotten. You can teach men how to start machines and they will follow the procedure with reasonable care but unless there is a definite and fixed routine for the inspection and checking and cleaning of instruments, and, unless this routine is insisted upon, it is not long before they are a liability instead of an asset, as they should be.

Condenser Leakage

The condenser itself is something like Mohammet's mountain, there is little the operating man can do to it except walk around it and see that the auxiliaries are doing their part. Leakage, both air and water, are the things that must be looked after. Heat bakes out the packing and the gaskets so it is important to see that cooling water is on before the steam goes into the condenser and that the pumps are kept running to cool the shell after the turbine is shut down.

It is a good idea to check the leakage each time the unit is shut down or frequently enough to be sure that the feedwater is not being contaminated. This is not as difficult as it sounds. The easiest way is to maintain a high vacuum and note the rise of water in the hotwell. There will be some leakage and also a natural flow from the glands and turbine so that the test is simply a matter of comparison with the normal rise. If the same procedure is used each time any undue leakage is easily detected. Of course if there is a chemist around or if you have an electric tester it is a simpler matter to take a sample of the hotwell water and test it. This method is very easy and simple if salt water is used for cooling in which case it is much more important to eliminate the leakage.

Undue air leakage can usually be caught by the operator from his knowledge of the normal vacuum readings for a given load and the number of steam jets in use. It is a good idea to check the leakage each time the machine is shut down, by closing the suction to the vacuum pump and noting how long it takes the vacuum to drop a given distance.

Circulating Pump

When it is time to start the circulating pump the condenser should be inspected to see that all waterbox doors are closed. The discharge valve on the pump should be closed and the oiling system inspected. After water is admitted to the water glands and the suction valve closed the pump can be primed (the condenser, too) if water does not flow to it under a positive head.

When the pump and shell are filled with water the pump can be started. If the oiling system is working properly the pump can be speeded up till the desired pressure is reached and the discharge valve slowly opened before the final speed is adjusted and the primer stopped. The intermediate procedure will depend upon the type of pump drive. Regardless of this, however, the pump should be started with the

*This refers to the operating codes for the Hiram Walker Distillery published in three parts: p. 159, March; p. 237, April and p. 362, May issue.

discharge valve closed because this gives the lowest horsepower requirements for starting and this is important especially with a motor drive.

After the pump is running the oiling system should be inspected again and there should be a slight leakage of water from the gland for lubricating the outer rings of packing. If no priming system is used the vent valve in the top of the pump casing should be opened until water runs out before the pump is started. When the pump is stopped, some time after the turbine is stopped, the discharge valve should be shut and the gland water shut off.

Before the hotwell pump is started, water should be turned on the seals, the oiling system inspected and the vent or equalizing line from the pump to the hotwell opened up. The pump can then be started and the discharge valve opened. Inasmuch as there is a vacuum on the condenser before the hotwell pump is started and the turbine is not yet running the hotwell should be watched to be sure that the pump is running at the proper speed to drain the hotwell after the turbine gets going.

Shutting down is simply the reverse of the above, the discharge and vent valves should be closed. Sometimes the hotwell pump is not started until the high water alarm on the hotwell sounds or until the water approaches the upper end of the glass. The vacuum being carried at this time, during the warming up period is probably low to avoid overheating the turbine. It is a funny thing but during starting up the steam warms the first part of the spindle but cools the last part which is heated by windage. With a high vacuum little steam is needed to turn the rotor slowly and consequently there is not enough to cool the last rows of blades.

When it comes to the auxiliary turbine the driver and driven machines act as a unit and the two must be inspected and started at the same time so that each machine would have to have its own specific set of instructions. To avoid repetition the following is a brief general outline. See that the exhaust valve and drains are open. Inspect the gears, if any, and the oiling system seeing that there is sufficient oil, that water has not collected below the oil, and that the strainer is clean. Set the emergency trip and close the overload nozzles.

Then the turbine may be started slowly, the engineer listening for unusual sounds, for a well-trained pair of ears are about as important to an engineer as an observant pair of eyes. Inspect the oiling system again and turn on the water in the oil cooler. Bring up to speed, close the drain valves, and, it is well, to test the governor by pressing down to slow up the machine and see if the governor brings it up to speed promptly when the hand is removed.

When shutting down it is well to unload first, if that can be done, then stop, preferably with the emergency trip. Close the throttle valve and exhaust valve and open the drains. The overspeed trip on a turbine is of extreme importance and should be kept in good working order. It should be tested occasionally. This is easily done by bringing the turbine up to speed, applying a tachometer and then pushing the governor gently so as to bring the speed up slowly until the overspeed trip works, or, until the speed is about five per cent above normal. If the trip does not work at this time it should be properly set. In fact, two to three per cent overspeed is sufficient margin on a small high speed unit.

Steam Jet

The steam jet is a simple piece of equipment that looks complicated and is apt to cause dismay to an inexperienced engineer. It is essentially simple and should be mastered fundamentally before the complicated practical equipment is tackled. A two or three element steam jet in two or three stages is bound to have a lot of piping and valves.

When the turbine is ready to warm up and ready for vacuum, turn water on the outer and after stage condensers, open the suction valves to the main condenser and drain valves on the outer and after stage condensers. Turn steam on all the secondary nozzles and adjust to the proper operating pressure. Open the equalizing valve between the intercondenser and the main condenser. When ready for the high vacuum, put the primary jets in operation and after the unit is operating at sufficient load to furnish cooling water switch from raw water to condensate.

Of course, the code for a particular plant can be extended indefinitely as there is a variety of auxiliary equipment around all kinds of pumps, blowers, compressors, engines, etc., around an industrial plant. Then there are instruments. These should be checked for zero frequently and calibrated at intervals. Some instruments have oil seals that should be kept up, flow meters have lines that should be blown out periodically, CO_2 meters have suction lines that clog up and filters that must be cleaned while some types need new absorbants and chemicals periodically.

These are but a few of the major items around a plant that were not covered by the other codes. Preparation of these codes is a good practice. It not only trains the men properly, but gets them in a definite routine that is important in emergencies when one has to act subconsciously without time for thought. It's good for the Chief, too. One good way of finding out just how much you know about a thing is to try and tell it to someone else so that it is understandable.

Caveat Emptor

We are told about a youngish matron who entered the household appliances department of Abraham & Strauss, over in Brooklyn, accompanied by her young son, and asked to see a refrigerator. They showed her one of their best models, a massive thing with all sorts of gadgets. She liked it fine except for one feature—the little automatic inside light which is controlled by the opening and closing of the door. "My light bills are high enough as it is, without having that burning day and night," she said. The clerk did his best to explain that the light went out as soon as the door was closed, but she was obstinate. "How do I know it goes out?" she said, reasonably. The clerk called other clerks and the section manager to his aid, but without getting anywhere to speak of. It was the lady who finally solved the problem. "Get in, Junior," she said, "and see if the light really goes out." Junior got in, they closed the door on him for a moment, and he came out with his report: "o.k., Mamma."

New Yorker.

COMBUSTION CONTROL

Part XVII. The electrically operated control system of Shallcross Controls, Inc.

BASICALLY, the Shallcross Control, like other combustion control systems, is designed to maintain a substantially constant steam pressure and to burn the fuel economically. Steam pressure is a reliable indication of fuel supply to load and if maintained constant the heat release in the furnace must of necessity be equal to the heat loss in the steam and in the flue gases. Fuel economy results from the proper division of these two losses so as to reduce the last one to the practical minimum. This is done by supplying the proper air for each rate of fuel burning and maintaining the best combustion conditions in the furnace.

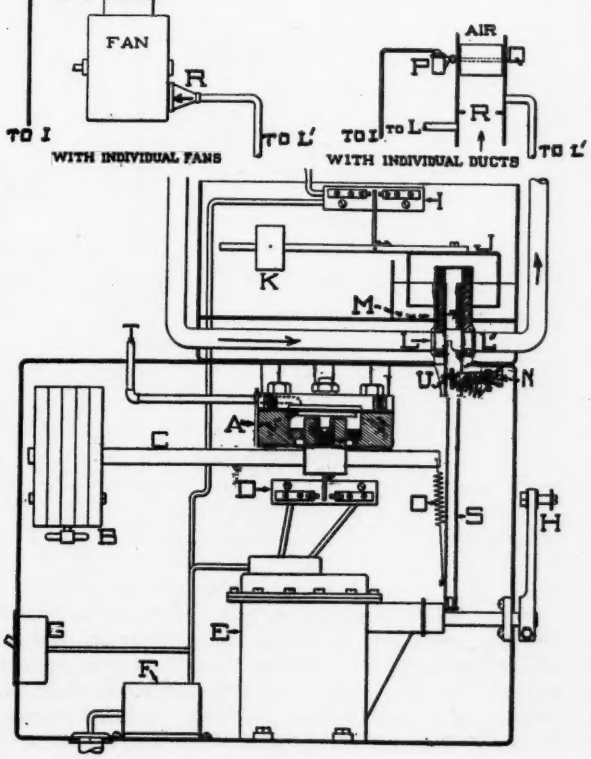
The complete control, therefore, consists of three parts, which in the order of their importance from an economy standpoint are: The furnace draft control; the steam pressure control regulating the fuel feed; and the air flow control.

The first is an independent unit which in the Shallcross system maintains a constant furnace pressure by operation of the boiler outlet damper or induced draft fan, and details of the regulator itself are shown by Fig. 2. The second part translates variations in steam pressure into demands for more or less fuel. Standard units are built for pressure up to 400 lb. per sq. in. and sufficiently sensitive to maintain steam pressure, within 1 per cent plus or minus. Details of the unit are shown by the bottom part of Fig. 1; crank H con-

Fig. 1. Shallcross Type MC Combustion Control

This controller contains all the elements characterizing the Shallcross system and various combinations and arrangements of these elements, are sometimes used to meet specific requirements. Some of these are shown by later illustrations, for instance Fig. 4, which uses the gasometer J and variable orifice valve M, and the master controller of Fig. 4 which uses the pressure switch and motor, A, D and E with a selsyn sending motor replacing the crank H and valve rod S.

Steam pressure to be controlled acts on the top of diaphragm A through pivots to weigh loaded beam C and closes or opens contacts D. Electric power is brought in through line switch G and stepped down to 25 v. by transformer F before reaching contacts D and I and motor E.



A drop in steam pressure, indicating an increase in steam load, causes weight B to drop and close the right hand contact D to operate the motor and turn crank H to increase the coal feed, at the same time, pulling down the air control valve rod S. As S drops the tension, in stabilizing, or, compensating spring O, will be increased and finally reach the point where beam C will tip up to open the electrical circuit at D and stop the motor. The period of motor operation, or the contact time, will depend upon the pressure variation from normal, and, if the coal feed is directly proportional to the movement of H, the change in fuel feed is proportional to the change in pressure. The normal pressure may be varied at will by shifting weight B.

Air supply is varied in direct proportion to the fuel feed by means of the variable orifice valve M directly connected to rod S. With individual fans the air metering connection is taken at the fan suction as shown by the small sketch at the upper left hand corner. With ducts, an orifice is used as shown by the sketch at the right. In either case the air flow to the furnace varies as the square root of the measured pressure differential and it is the function of the orifice valve M to change the square root relationship so as to control the air flow in direct proportion to the coal feed.

This is done by the use of two orifices, L and L^1 as shown. Normally one of these orifices, L^1, remains constant as the rod S moves up and down while the other, L, varies directly with the vertical travel, being at a minimum for the top position of S. As this area changes, the pressure between the two orifices, i.e., the section under the gasometer bell J, changes. This bell, however, is set by weight K to maintain a constant suction at this point and as the orifice area L is changed, for instance, increased by a downward movement of S, the gasometer moves to close the left hand contact I, to open the fan damper and increase the flow of air so as to restore the gasometer balance. Due to the fundamental relationship of air flow, area, and pressure, the air flow to the furnace is directly proportional to the movement of valve rod S. In case the fuel feed is not directly proportional to the travel of H, the port areas in valve M may be changed from the rectangular shape so as to maintain the desired air-fuel ratio.

In addition to the vertical travel due to rod S, valve M may be rotated by means of the knurled knob N and the vane U, which is part of the valve M. Rotation of valve M in this manner decreases the area of one port and increases the other so as to change the air fuel ratio. This adjustment is made in the plant from CO_2 readings and remains constant for a given fuel. The air fuel ratio may also be changed by means of weight K. The two adjustments are not, however, the same. If the steam load (fuel) is plotted horizontally and the air flow vertically the control operates to maintain a straight line relationship between the two and the angle made by this line with the horizontal is determined by adjustment of Knob N and is best made at higher ratings from CO_2 readings. Adjustment of K determines the intersection of the line with the vertical axis and is best made at low loads when the port L is practically closed and the ratio valve inoperative.

In some cases it may not be desirable to maintain constant CO_2 or excess air over the entire range of boiler load. For instance, high excess air might be desirable at low ratings to give complete combustion and at high ratings to protect the furnace walls. An air-fuel ratio varying with the load may be maintained by bending the vane U which is made relatively soft and easily replaced for this purpose.

Connections for individual fan or duct pressure taps are indicated on the drawing. With individual fans but one suction connection is used and that connects with L^1, the right hand side of valve M, the other side, L, being open to atmosphere.

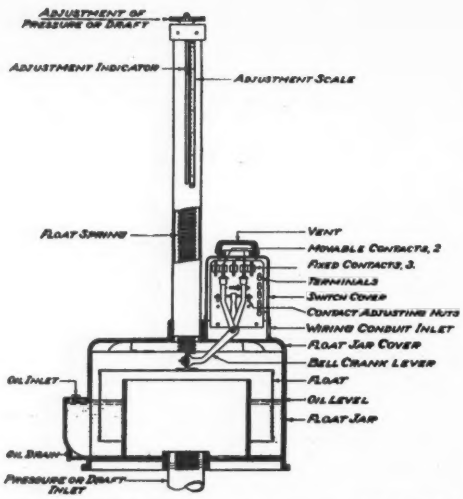


Fig. 2. Furnace draft regulator or pressure switch of the spring loaded gasometer type. A diaphragm type switch or weight loaded gasometer as shown by the top half of Fig. 4 is sometimes used for the same purpose

trols the rate of fuel feed. Part three, the top part of Fig. 1, measures the air flow to the furnace and regulates in proper proportion to the fuel feed. It is mechanically connected to the pressure control by valve rod S of Fig. 1. It is not necessary to know the actual fuel and air flow in pounds per hour but it is necessary to maintain a definite proportion between the two over the load range of the boiler and the Shallcross system does this by maintaining a straight line relation between the two, with the ratio adjustable so as to give the desired CO_2 reading.

In practice the combustion control consists of a master control for the plant and individual air controls for each boiler, but in Fig. 1 the two are shown mechanically connected as they would be for a single boiler. For a number of boilers the two units are connected electrically as shown by Fig. 5. The master control comprises a diaphragm type steam pressure switch, the counterweighted beam of which is mounted on hardened knife edges. This beam carries contacts operating a small, oil immersed motor in a sealed case,

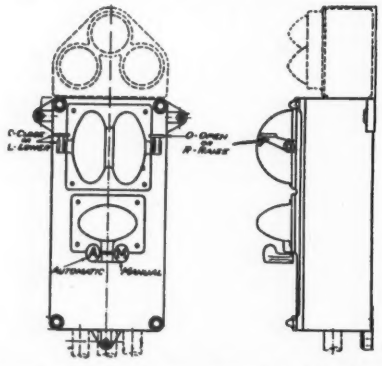


Fig. 3. Manual control station. Control is shifted to manual or automatic control by pushing the A or M button

When on manual control changes may be made by pushing the O or C button as desired. Type B with three signal lights, red, green and white is illustrated. The white light shows that current is on the control, for normal conditions all three are on but as the control opens the green dims and when the control closes the red dims. Type A is the same as type B but the lights are omitted. Types C and D are the same as A and B respectively with the addition of a resistance box for variable speed motor operation.

and carrying a crank shaft which controls the fuel feed. A compensating spring from the motor crank shaft to the steam pressure switch beam causes the motor to float with the boiler load. With this arrangement the motor takes up a definite position at each value of the boiler load, a slight change in steam pressure resulting in a slight change in fuel feed, a greater pressure change resulting in a greater fuel change.

Air to each boiler is measured, either by an orifice in the individual air duct or by the suction at the inlet of an individual fan. These differential pressures (or suction) are lead to an air switch (top part of Fig. 1), consisting of an oil sealed gasometer carrying contacts which control the motor driven damper in the furnace air duct. This control maintains a definite rate of air flow to the furnace, regardless of the changing resistance of the fuel bed in the case of a stoker, so that the under fire pressure will be raised as the fuel bed increases and lowered as the bed resistance decreases. The air differentials from the air duct orifice are led to the gasometer air switch through a bleeding valve which is mechanically adjusted from the master control motor. This valve is moved by the master motor as it changes the stoker speed in response to plant load changes.

The ratio of the air to the fuel is determined by a manual adjustment incorporated in each unit. This is

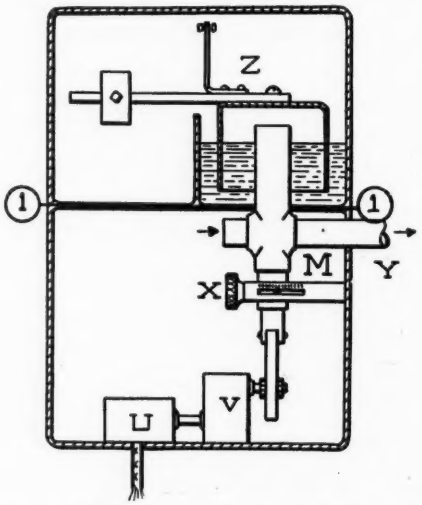


Fig. 4. Details of controls A and B of Fig. 5

That portion above the line 1—1 may be used as furnace draft control as explained in Fig. 2. In that case the furnace draft connection is brought in through the side of the case and up under the bell.

The Selsyn receiving motor U assumes a position corresponding to the master sending generator (0 of Fig. 5) and through gear V positions the variable orifice valve M (which is the same type as valve M of Fig. 1) to control the air flow to the exhauster fans (as a measurement of fuel flow) and to the forced draft fan. In this case fuel to the furnace is determined by measuring the air flow to the exhauster fans and the air fuel ratio is maintained by keeping both proportional to the rotation of the Selsyn motors. The air fuel ratio may be changed by changing the weight on the gasometer (2 of Fig. 4) or rotating the variable orifice valve of regulator B by means of a knob (X of Fig. 4) or by similar simultaneous adjustments on controls A. These two adjustments are mentioned in connection with K and N of Fig. 1.

in effect a CO_2 adjustment, since after the control is put into operation, the correct ratio of air to coal can be best observed by altering the adjustment and observing the CO_2. After the CO_2 has been set at the proper point this adjustment need not be changed unless the kind or quality of fuel is changed.

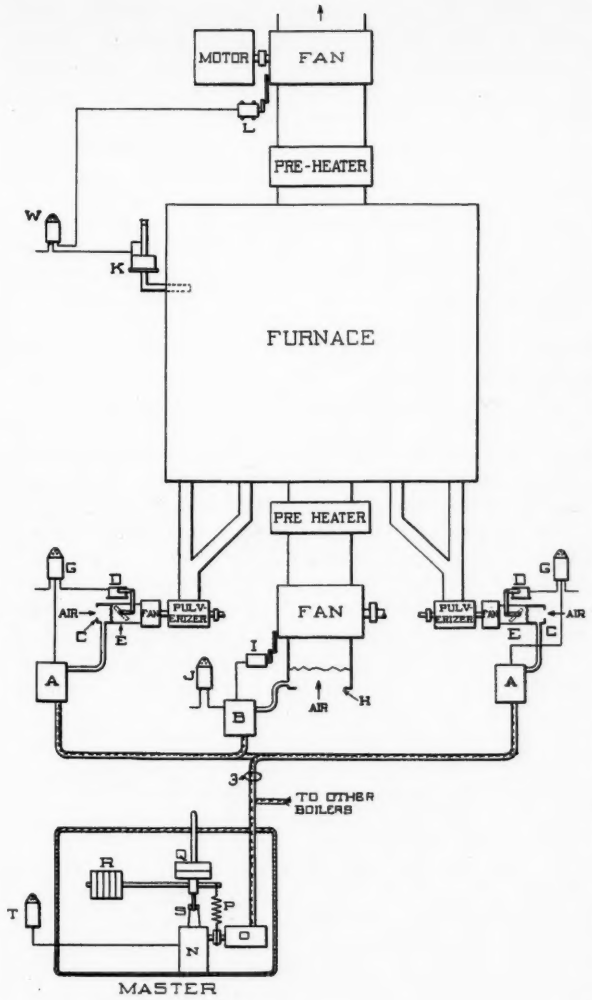


Fig. 5. Application of Shallcross Master control system to a large boiler

In this case the master controller consists of certain parts described in detail in Fig. 1. The Selsyn driving generator O is mounted directly on the shaft from motor N and assumes a position depending upon the steam pressure variation from normal. Similar receiving motors (U of Fig. 4) in controls A and B of each boiler assume a corresponding position and regulate the air and fuel (as explained by Figs. 1 and 4) by means of orifices C and H. If desired, however, regulators A could control the coal feed by means of feeders and time delay relays as conventionally used.

Both fuel feed and air flow are proportional to the position of the Selsyn motors and the ratio is maintained over the entire range of load. This ratio may be changed as explained by Fig. 4.

Furnace draft is maintained by an independent regulator K (shown in detail by Fig. 2) operating the induced draft fan.

Manual operating switches (Fig. 3) are provided for shifting from automatic to manual control. T allows complete manual control of the entire station from the master. A Selsyn sending motor station, 3, gives complete manual control of any individual boiler although this is accomplished in a simpler manner by interlocking switches G and J electrically or mechanically to give concerted action. In this case 3 would simply be a transfer switch affecting the interlock.

Manual stations G, J, and W are shown near their respective controllers for simplicity but would normally be grouped on the boiler panel. The boiler load control and the fuel-air ratio adjustments, X of controls A and B, respectively, may also be located at the same point to give complete control from a control station.

Entirely separate from the combustion control, the furnace pressure control, Fig. 2, consists of a furnace pressure switch controlling a motor on the breeching damper. This is also a floating type, the damper being continually opened or closed to maintain the desired furnace pressure. This correct furnace pressure for a given boiler is largely determined from the CO_2 and fom the temperature of the furnace lining. The furnace pressure switch, either of the diaphragm or gasometer type, is sensitive to less than 0.01 in. of water.

A manual station is provided for putting the control either on automatic or manual operation. When on the latter, the damper can be either opened wide, for soot blowing, or closed for banking, etc. This manual station can be mounted in any convenient location, on the instrument board, for example. Control motors operate from alternating current, 110 or 220 v. which is stepped down by a transformer in the control to 25 v. on the contacts and motors. They are adaptable to any kind of fuel or type of stoker.

Larger installations, in which the fuel is accurately proportioned to the load and the quantity of air accurately delivered in proportion to the fuel, are necessarily quite comprehensive and the smaller controls described above were developed to embody the refinements of the larger installations into smaller or universally applicable and less expensive controls for small boilers. For larger and more extensive installations they have been further developed as explained below.

A Large Installation

Figure 5 shows the scheme of a larger and more comprehensive installation. In this example the furnace is fired by two pulverizers, where the coal delivered to the furnace is carried through the primary air and its amount is proportional to the amount of primary air. This primary air to each pulverizer is drawn in by its fan through an orifice used as a metering element. Secondary air is delivered by a fan with adjustable inlet blades, through a preheater to the furnace. In this installation the master steam pressure switch drives a Selsyn generator and a compensating spring causes the master motor to rotate with the load as described in connection with the simpler controls. The Selsyn generator feeds Selsyn motors in the three combustion controls of each boiler of the plant, these Selsyn motors rotating with the master Selsyn generator to control the fuel feed and air flow as described by Fig. 5.

Furnace pressure is controlled by the usual pressure control consisting of the gasometer type switch K with its motor L operating the induced draft fan inlet vanes.

Manual stations are provided with each control to place them, all or singly, on automatic or manual control and when on manual control that particular function can be raised or lowered by hand and set at a definite point. These manual stations permit one boiler or one pulverizer or more of either to be operated at a definite load, the other boilers in the plant carrying the load swings. Signal lights on each manual station show whether the control is operating properly, whether the load is rising or falling, whether the control is on automatic or manual, etc. These manual stations are usually grouped on the instrument board or control panel. The manual station at the master allows manual operation of the entire plant from a single point. Manual control of a single boiler as a unit is obtained from another manual station which is either an interlock of the three manual stations on that boiler or a separate manually controlled Selsyn sending motor.

Secondly, adjustments of the various functions can be adjusted to suit operating conditions. The draft maintained in the furnace can be adjusted at the furnace draft switch. The rate of fuel response to load changes is adjustable at X (Fig. 4) on controls A of Fig. 5. This adjustment controls the rate of response of the boiler to load demands and is set by the character of the plant load; whether widely fluctuating or steady. This adjustment is also used to proportion the load among the various boilers and among the various pulverizers. Any boiler or any pulverizer can be set to carry a definite proportion of the load. This boiler or pulverizer will then swing up or down with the total plant load, carrying its adjusted proportion. This adjustment may or may not be remotely controlled from the boiler control panel. The ratio of the secondary air to coal is adjusted at X (Fig. 4) on control B of Fig. 5. This adjustment is set from the CO_2 indications and is in effect a CO_2 adjustment as explained earlier. The steam pressure maintained by the boiler is adjusted by the counterweight on the master control.

The system as shown is completely electrical in operation. There are no connections between any units of the system except wiring in conduit, and all parts are self-contained and in dust proof cases. In cases where hydraulic operation is necessary it is obvious, however, that the controls can be adapted to this service either by having the motor operate a valve controlling the flow of fluid, by having the contacts operate solenoid valves, or, by having the contacts control individual reversible oil pumps at each control station.

Lake Mead Doubles Its Size in Two Months

LAKE MEAD, CREATED in the canyons of the Colorado River by Boulder Dam and already the largest man-made body of water in the world, has doubled its size in two months. It now contains 7,000,000 acre-feet of water.

Recent measurements of Lake Mead represented an increase of 1,000,000 acre-feet of water in nine days, John C. Page, Acting Commissioner of Reclamation, reported to Secretary of Interior Harold L. Ickes.

Seven million acre-feet of water is 2,287,000,000,000 gal. sufficient to supply all the needs of a city the size of Chicago for 15 years.

The Colorado River has not yet reached its peak flow for the season, but today it released 127,000 acre-feet in Lake Mead, while 19,000 acre-feet were being diverted past Boulder Dam to supply the needs of irrigators downstream.

The depth of Lake Mead has been increasing about one foot a day and has now reached a total of 344 feet near the dam. The lake was 91 miles long today, extending into the extreme lower portion of Grand Canyon.

"The steady growth of Lake Mead this spring," Mr. Page said, "is not only adding to the security of the tens of thousands who depend upon the lower Colorado River for their livelihood, but has created and is enlarging one of the most unique recreational areas in the world.

"Canyons that were inaccessible before the lake began to form 15 months ago now can be reached easily by boating parties from Boulder Dam. These include such sheer-walled gorges as Boulder Canyon and Travertine Canyon and Virgin Canyon as well as the ragged colorful Iceberg Canyon and an unfrequented stretch of the marvelous Grand Canyon."

Installation of the machinery in the powerhouse at Boulder Dam is proceeding rapidly, Ralph Lowry, Construction Engineer, has reported. It is expected that initial tests of the first generators can be begun in the late summer with generation to be started about 30 days later. Lowry said the installations were 70 per cent complete.

$38,000,000 for Municipal Power Projects

AN APPROPRIATION of $38,350,147 is being made available for Federal aid for municipal power projects in different parts of the country and a heavy construction program will be carried out during the summer and fall, as soon as final details have been arranged. This sum is provided for in the deficiency appropriation bill which has passed the Senate, with provision removing the restriction on the Public Works Administration revolving fund; under this measure, $300,000,000 heretofore restricted for loans to states and municipalities can be used for grants. Approval by the House will be only a matter of routine, in view of the President's approval and the large group of Representatives favoring the program. The PWA has a total of 3475 projects of various kinds scheduled for Federal aid at this time, of which 63 are power projects, with estimated cost of $38,350,147, as noted. The latter comprise a heavy allotment of municipal electric light and power plants, primarily in the middle western area, as well as electrical distributing lines and service facilities. Three such projects of last noted character are located in Tennessee and have secured PWA approval. These will be at Memphis, Chattanooga and Knoxville, respectively, all of which propose to use power from TVA system; Memphis will have a Federal grant of $3,092,000 for its proposed new system, estimated to cost $6,872,000, with transmission lines, power substations and service facilities; Chattanooga has approval of a grant of $1,948,000 for a similar system to cost $4,330,000; and Knoxville will secure a grant of $90,000 for a $200,000 project for extensions and improvements in electrical distributing system and facilities. One of the largest single developments is that at Sacramento, Calif., which has obtained approval of a Federal grant of $5,400,000 for new municipal electrical distribution system, power substation and switching facilities, and expansion in service, estimated to cost $12,000,000. With these developments, approximately $28,000,000 will be available for the other municipal power projects.

DEFINITIONS and tables of equivalents of customary weights and measures of the United States and the metric system are given in a new publication of the National Bureau of Standards, Miscellaneous Publication M121 which supersedes Circular C47 issued in 1914. Copies are available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 ct. each.

Waste Heat Recovery *from* Diesels

Economizers and heat exchangers offer means of greatly improving thermal efficiency of plant. By E. G. Sims, The Sims Co., Erie, Pa.

WASTE HEAT, in the exhaust gases from an internal combustion engine, has always been regarded as a potential source of additional power. Only in recent years, with the increased popular favor of the Diesel engine, have rapid strides been made to scientifically recover this valuable energy. As the power of marine propulsion Diesels increase and larger industrial Diesel power units for land service are installed, this source of free energy cannot be overlooked.

The exhaust gas leaving the engine at relatively high temperatures can be economically reduced with a properly designed exhaust gas economizer. Such an economizer as built by The Sims Co. and shown by Fig. 1R is of steel, welded and riveted, according to A.S.M.E. Code, is designed for 100 lb. WP, and constructed and operated similarly to a vertical fire tube boiler. The tubes are grouped in one pass through which the exhaust gas flows. Tube area and volume of exhaust gas from the engine must be evenly proportioned, so that the minimum pressure loss through the economizer does not exceed 0.5 lb. or approximately 11.5 in. of water for four cycle engines, or 1 in. of water for any two cycle engines. These exhaust gas economizers must be properly insulated with a good grade of insulation and ordinary asbestos insulation is not desirable for this service.

The economizer must be accessible for cleaning the interior. The necessity for cleaning the inside of the tubes depends largely on the complete combustion of the fuel. With an engine of good design there will be complete combustion of the fuel, reducing carbon deposits and lessening the need for cleaning. Due to the fact, that tubes are the first to disintegrate, the top and bottom covers are removable to facilitate replacement when necessary.

Another source of heat loss is the jacket cooling water and the heat exchanger offers a practical method of recovery. A heat exchanger is a piece of equipment that transfers heat from one medium to another and the type built by The Sims Co. for this service, shown by Fig. 1 B is the closed type, in which there is no direct contact or mixing of the two mediums, heat being transferred through the tube walls. This type of heat exchanger is made up of seamless tubes grouped in a series of passes through which one of the mediums is circulated and the other is passed around the tubes. They are built so that the tubes are rolled into the tube plates in a fixed position. The cooling water is passed through the tubes directed in its flow by partitions cast into the covers; the jacket water is circulated through the shell directed in its flow by baffles across the tube surface.

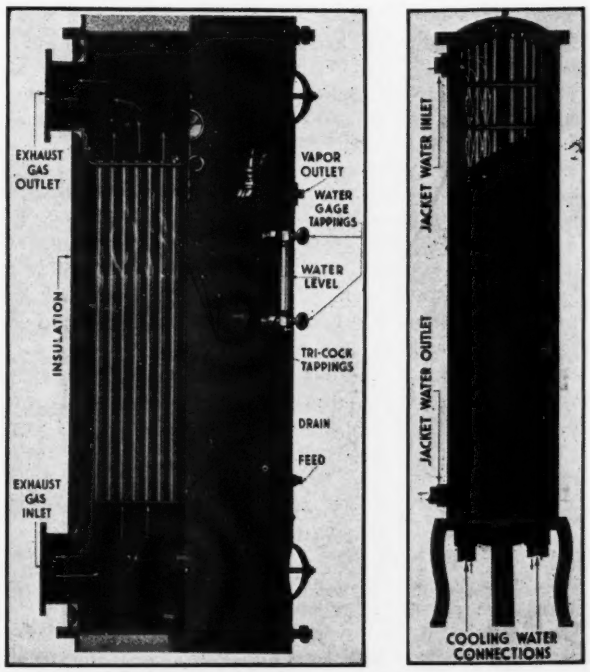


Fig. 1. (Left) Economizer or waste heat boiler and (right) heat exchanger as made by The Sims Co. for Diesel service

Cleaning in this type exchanger is not one of major importance if the proper design has been followed to produce the correct velocity for both the cooling water through the tubes and the jacket water around the tubes. Often the cooling water used is contaminated with heavy lime deposits or sediment so it is essential that the covers be removable for cleaning the inside of the tubes without the necessity of breaking pipe joints.

Comparatively low temperatures used are generally out of the range which produces rapid scale formation, but when cleaning is necessary, the procedure is simple. The tubes are filled with a solution of water and 10 per cent commercial muriatic acid, by volume in water. This solution quickly reduces the scale to a sludge

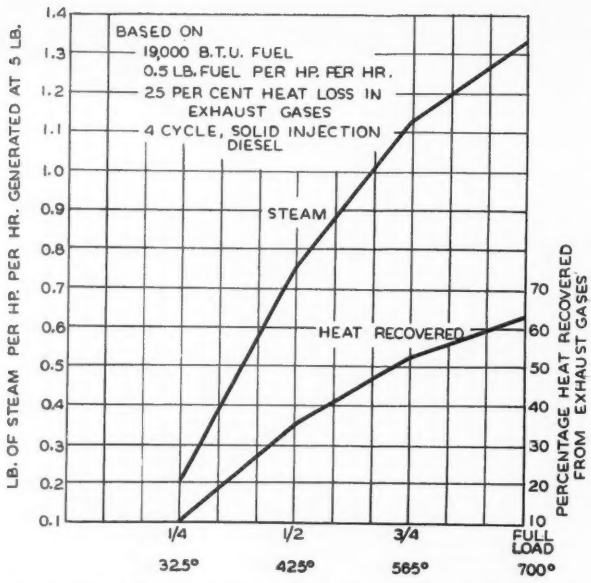


Fig. 2. Typical capacity curve of an economizer as a function engine load

which may be washed away. No further cleaning is necessary.

Heat exchangers are used for both land or marine service. The material used for land service is cast iron and steel with copper as the heat exchange surface, while for marine service, where sea water is used as the cooling medium, it is necessary to use bronze covers, tube plates, and admiralty metal tubes. This construction for marine service is essential for any extended life of the equipment because of the very corrosive action of sea water when its temperature is raised.

This auxiliary piece of engine equipment is very important for Diesel engines as their construction of close machine tolerances, controlled jacket water temperatures are of vital importance. An exchanger insures free passage of clean jacket water through the engine in the proper volume, eliminating the cold area in the lower part of the cylinder, and any high temperature fluctuation of the jacket water, which are detrimental to engine economy and performance.

In districts where the water is contaminated it is possible to fill the engine jackets with distilled water, circulated between the engine and the exchanger, using contaminated water for the cooling medium, doing away with the possibility of corrosive action occurring in the engine proper. It is also possible to preheat cold water under pressure as the cooling medium for useful service in the hot water supply.

Useful heat that can be transferred from the jacket water varies with the type and make of engine. Each engine has its own power characteristic curves and the heat transfer must be calculated from these curves. No rule of thumb methods should not be used for the calculation of the heat losses and expected recovery. The engine builder should be consulted for both the characteristic curves of the engine and his recommendation.

In conjunction with the proper installation of a heat exchanger, care should be used in the selection of the pump that circulates the raw cooling water. Only the totally enclosed impeller design should be considered as other types of centrifugal pumps produce greater agitation of the circulating water, releasing free oxygen in amazing quantities and increasing the rate of disintegration of any metal coming in contact with it.

The heat exchanger is being accepted as a necessary piece of equipment for the Diesel engine. It also merits the attention in the case of existing and proposed installations of gas engines for land service and in the smaller horsepower gasoline engines for marine service. Engine builders realizing the importance of heat exchangers have coöperated with heat exchange manufacturers until now, practically every Diesel engine has a heat exchanger design for its own power characteristic curves and a guaranteed performance may be given.

Figure 1 typifies the results that may be expected from a Diesel engine but these curves cannot be accepted as a base for capacities obtained from all engines. Of the sixty odd per cent, of the total heat in the fuel which appears in the cooling water and exhaust gases, all the heat in the water, and about half of that in the exhaust, is recoverable. The balance is accounted for by radiation and the portion of exhaust heat not economical to recover in the exhaust gas because of lowering the temperature below the dew point, causing excess corrosion in the tubes of the economizer, or because of higher cost for adequate recovery surface.

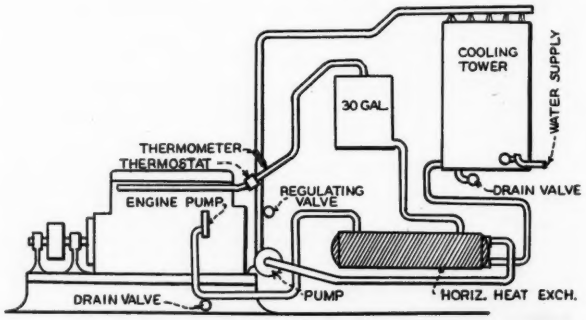


Fig. 3. Heat exchanger used with a closed system of water cooling

High or low pressure steam which can be supplied from this waste heat can be used in a score of ways through the plant or ship. The rate of heat transfer depends upon the mean temperature difference between the exhaust temperature and the temperature of the water to be heated or steam to be generated. This difference should be as great as possible by not attempting to generate steam at high pressure, as high pressure

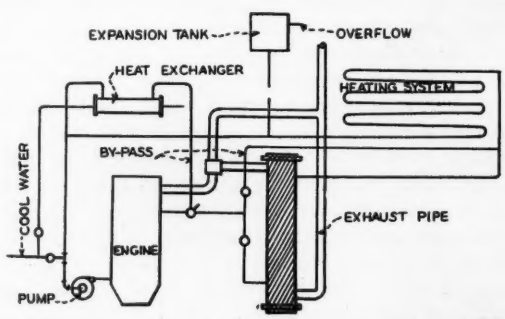


Fig. 4. An economizer and heat exchanger hooked up for plant heating

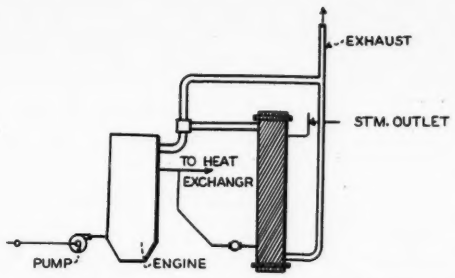


Fig. 5. An economizer arranged for low pressure steam generation

steam means high temperature exit of the exhaust gases from the economizer and low heat recovery.

This type of economizer is not only capable of recovering heat that would have been wasted but also acts as a very efficient muffler as the exhaust gases, when they enter the economizer, are reduced in temperature thus decreasing the volume, and velocity and muffling the sound.

Output of the economizer depends entirely on the brake horsepower developed by the engine and the temperature of the gases exhausted from the engine. The variables include: the make, size and type of engine; actual horsepower; load; temperature of the exhaust gases at the end of the manifold; fuel used in pounds per horsepower per hour; feedwater temperature; service of the economizer, i. e., if it generates steam, the pressure, or if it is intended for heating water, the final temperature.

Oil Maintenance *in* Industrial Plant Breakers

By K. B. HUMPHREY

MANY INDUSTRIAL plants now have 2300 v. service which requires the use of oil circuit breakers and compensators. The actual number of breakers may be rather limited and consequently the use of oil testing apparatus and oil purifying units are out of the question from an economic standpoint. Such a manufacturer is often in a quandary as to the best methods to use in maintaining the breakers in a safe operating condition. There is no question but that a test of the oil and purification if needed is the best, but a lot may be accomplished by means of regular inspection and a change of oil when necessary.

Oil filled breakers and compensators should be inspected at least once every three months and never longer than six months. Breakers under severe service should be looked at oftener, perhaps once a month. The apparatus should always be inspected after it has opened an overload or short circuit current before being put into service again. Some manufacturers recommend that, in the absence of a regular spark test, the oil should be changed every six months. Others place the time limit as a year. Naturally the change of oil should be made in plenty of time so that no serious trouble has a chance to develop.

Carbonization and moisture are the two principal things which cause deterioration of oil in service. The oil becomes carbonized, that is, flakes of carbon appear in the oil, from actual use and some is formed every time the breaker is opened even under light loads. It will be indicated by a black deposit forming on the insulating bushings, the sides of the tank, and the bottom. If the oil is stirred slightly the carbon can be easily seen, especially if the tank is placed in the bright sunlight. The amount of carbon can only be judged by experience but it may be discerned whether there is any great quantity present without difficulty.

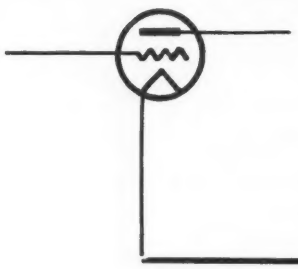
Moisture does not show up so easily. It enters the oil by condensation on the surface of the oil and on the parts exposed above the oil level. Excessive moisture may be indicated by the appearance of rust spots on the cover. If this condition is noted upon inspection the oil should be changed before putting the apparatus back into service.

If the circuit breaker or compensator heats up under load it is a pretty sure sign that the oil contains a considerable quantity of carbon and moisture and the oil should be changed. This is assuming of course that the contacts are in good condition. The practice of one manufacturer employing a number of oil filled breakers about the plant is to make a thorough inspection every three months and to change the oil at least once a year. If inspection seems to warrant it the oil is changed oftener. After all, with only a small number of breakers the cost of changing the oil frequently is not excessive and the insurance against shutdowns and safety for the operators is well worth while.

Frequent inspections and a regular change of oil in accordance with a schedule are the things necessary to keep oil breakers in shape so that when they are called upon to open a heavy current at their rated capacity or over, there will be no danger of damage to the breaker or danger to the operator.

Brush Wear in Hydrogen

OUR PRESENT KNOWLEDGE of the exact processes of brush wear is meager. It has been found, however, that by a change from air to hydrogen operation, life of slip-ring brushes can be increased from two or three years to 50 or 100 years. Besides having considerable scientific interest, this fact may also have considerable practical significance. This conclusion is partially confirmed by actual operating experience with hydrogen-cooled synchronous condensers over a period of six years. In one case, in which the collector rings were steel, with grooves in the surfaces, no brush wear was observable during two and a half years of service. Another experience—if somewhat less favorable—involved other causes of brush and collector-ring difficulties. If the very great reduction in the rate of brush can be accomplished, as it would seem, by simply maintaining a chemically inert gas around the brushes, it should prove very desirable to adopt this method on certain special machines in actual service.—ELECTRIC JOURNAL.



PART VI. The effect of introducing gas into a thermionic tube. A discussion of the principle of ionization and how it affects the operation and characteristics of electron tubes. A brief consideration of "space charge" and its neutralization by positive ion formation. Simple applications of the two electrode gas filled tube.

Electron Tubes — Principles *and* Applications

By A. W. KRAMER

BEFORE CONTINUING THE discussion of the three-electrode tube presented in the two preceding articles, it will be expedient, though perhaps not entirely logical, to interrupt the discussion here and proceed to a consideration of another aspect of electron tube phenomena. There is, of course, a great deal more to be said about triodes, indeed, the discussion so far represents only a bare introduction to the subject, but rather than become involved in a detailed consideration of the characteristics of this particular tube at this point, it will be to our advantage to digress and investigate another phase of electron tube phenomena which applies to diodes and other forms of tubes as well as triodes. We shall return to a more detailed study of the triode further on in this series.

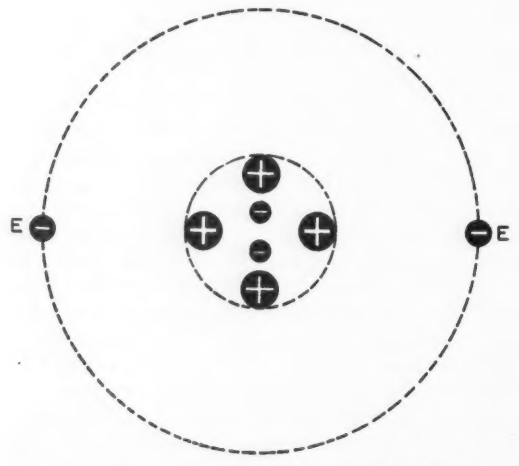


Fig. 1. Conventional diagram of the neutral Helium atom. It consists simply of a central nucleus in which are disposed in close proximity four positively charged elements known as protons, and two negatively charged elements called electrons. At a distance from this nucleus, two external electrons revolve in a closed orbit as shown. The negative charge of these two external electrons compensates for the excess positive charge of the nucleus

In all of the tubes considered so far, regardless of whether or not a grid was present; the space between the cathode and the anode has been assumed to be empty, that is, a vacuum. Of course, no space within any tube ever made has been a real vacuum; with the utmost precaution and the best evacuating apparatus and methods available, the resulting vacuums still have millions of molecules of gas per cubic centimeter. For most practical purposes, however, such vacuums are adequate and insofar as the flight of electrons from the cathode to the anode is concerned, tubes containing such vacuums can be considered empty. The molecules are so small and the space between them so great in comparison with their size that it is only very rarely that an electron will encounter a molecule in such rarified atmospheres.[1]

As a consequence of this explanation of conditions in an ordinary vacuum tube, a natural question that arises in one's mind is this: What effect would the presence of gas in the tube have upon its operation? In other words, if, instead of a vacuum, a relatively large amount of gas were left in the tube, how would this affect the tube's operation?

As can be readily imagined, under such conditions, the operation of a tube differs materially from that

[1]Even in a very good vacuum, say 10^{-7} mm. Hg., there are still about 10^9 gas molecules per cubic cm. which means that their average distance is only 10^{-3} cm. Small as this distance seems, it is equal to 100,000 times the diameter of the atom. The earth is at a distance from the sun only about 100 of the sun's diameter, so in this good vacuum the relative spacing of the atoms is as though the earth and sun were separated 1000 times their present distance. Thus, there is plenty of space between the gas atoms for the unimpeded motion of electrons emitted from the hot filament.

of the high vacuum tube, for, with gas molecules inside the tube, there is no longer a "clear" path for the electrons in their passage from the cathode to the anode and many if not all of the emitted electrons will collide with gas molecules. Now, the molecules and also the atoms of even the lightest gases (hydrogen and helium) are hundreds and thousands of times more massive than electrons and in the absence of more specific knowledge it would be reasonable to suppose that when an electron collides with an atom or a molecule, the electron would be stopped and that it would never reach the plate. To a certain extent, of course, this is true but it does not take into account the process of "ionization" as it is known.

To explain this it is necessary to revert, briefly, to some of the fundamental facts regarding the structure of matter. All matter, as is well known, is composed of molecules or atoms—the molecules being groups of atoms. The atom is itself a complex structure consisting of a central portion called the nucleus surrounded by one or more electrons revolving in closed orbits. In Fig. 1, for example, is shown a conventional diagram of a Helium atom. The Helium atom has been selected for this illustration because it happens to be one of the simplest atoms, structurally, but the principles to be described apply in the case of any other atom.

This Helium atom, it will be noted, consists of a nucleus in which are disposed in close proximity four positively charged elements known as protons and two negatively charged elements called electrons. Since this nucleus has two more positively charged elements than it has negatively charged elements and since the positive and negative charges are equal in strength, the nucleus as a whole is unbalanced and exhibits a positive electrical charge of "two." This unbalance, however, is compensated for by the two "external" electrons travelling in a closed orbit outside of the nucleus. The atom as a whole, therefore, is electrically neutral.

The Process of Ionization

The external electrons, however, are quite loosely bound to the nucleus and if sufficient force is applied they can be removed from the atom. Suppose that a small high speed projectile E is fired at the atom, as shown in Fig. 2, and that this projectile collides with one of the orbital electrons E as indicated. If the energy involved is sufficiently great the orbital electron

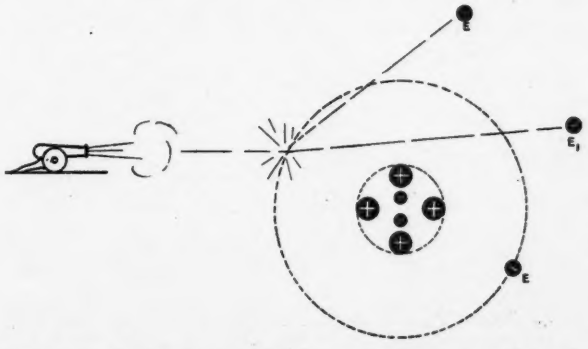


Fig. 2. Illustrating the principle of ionization. If a projectile E, is fired at an atom with sufficient force, it is conceivable that the force of impact might disrupt the atom, liberating one or more of the electrons

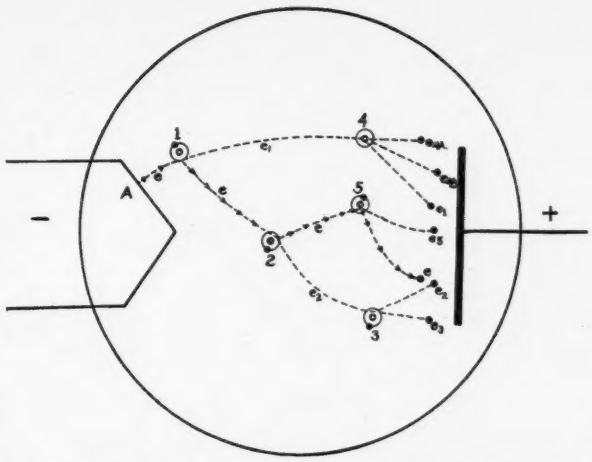


Fig. 3. The effect of "Ionization" in a gaseous tube. A single electron e emitted from the cathode at A is accelerated by the positive field until it collides with atom 1. Here the force of collision liberates electron e, which also is accelerated by the field until it disrupts atom 4, liberating two additional electrons, E_{4A} and E_{4B}. The original electron e in the meantime has ionized atoms 2 and 5, and the product of the ionization of atom 2 in turn has ionized atom 3. The net result of these successive collisions, therefore is that instead of a single electron, we have seven electrons reaching the plate

E will be knocked clear out of the atom, leaving the atom deficient of one electron. Under these conditions the atom is said to be ionized and of course exhibits a positive electrical charge. The electron which has been knocked out of the atom is, of course, negatively charged and will be attracted by any positive charge in its vicinity.

The Effect of Ionization in a Gas Filled Tube

This is a rather crude way of explaining it, but this is exactly what occurs in a tube in which gas is present. Instead of the gun shown in Fig. 2 there is a cathode surface emitting electrons. These electrons are acted upon by the electrostatic field existing between the cathode and the anode and they are accelerated by that field in the direction of the anode.[2] The space between the cathode and anode, however, contains large numbers of atoms and so there is considerable probability of an electron colliding with an atom before it reaches the plate. If, at the time this collision occurs, the electron has acquired sufficient velocity, it will strike with such force as to remove one or more of the orbital electrons from the atom, leaving the latter ionized.

This action is known as "ionization by collision"[3] and it plays an extremely important role, not only in electron tubes, but in all electric arc phenomena.[4]

Consider, for example, the action of the presence of gas in a two element tube, a diode. Such a tube is shown, diagrammatically, in Fig. 3 and for the sake

[2]Another way of looking at this is to think of the electrons as moving from a place of excess to one of deficiency in the same way that a crowd of people move into the empty seats of an auditorium or theatre. The plate is continually deficient in electrons because it is connected to the positive terminal of a battery.

[3]Ionization can be accomplished in other ways also, i.e., thermally for example, where the removal of electrons is the result of thermal agitation of the molecules or electrolytically, in which case the dissociation is due to the attractive influence of neighboring molecules of water. In a salt solution, for instance, ions are formed spontaneously without the aid of an electric field.

[4]For detailed information see Theories of the Electric Arc in the author's book, "Electricity—What It Is and How It Acts," Vol. 1, p. 250.

of simplicity we shall consider the action resulting from the emission of a single electron, e, from the cathode at the point A as indicated. In an actual tube, of course, millions of such electrons are emitted from all parts of the cathode surface but, here, we will ignore all of them except just the single one shown and we shall folow it in its journey toward the plate.

An instant after the electron emerges into the space between the cathode and the plate it is acted upon by the positive field due to the plate and it is accelerated along the path shown. At the point 1, however, it collides with an atom and strikes it with such force as to dislodge one of the electrons e_1 normally belonging to that atom. This electron, e_1 is also acted upon by the field due to the plate and therefore is also accelerated in a direction toward the plate. At a point

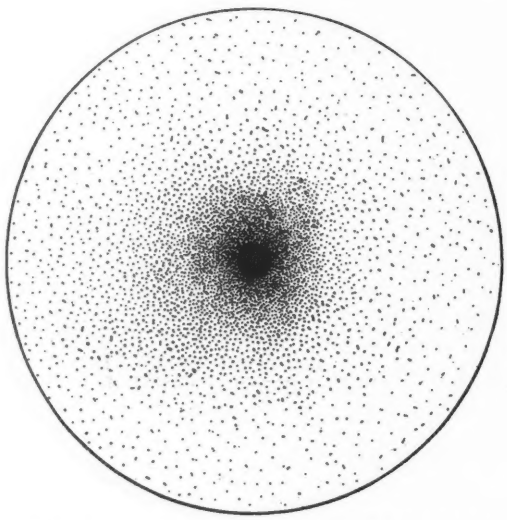


Fig. 4. Distribution of electrons around a cylindrical cathode placed at the center of a cylindrical anode

4, however, this "freed" electron also collides with another atom of gas and in this case the force of impact is so great (for the electron has acquired great velocity) that, not one, but, two electrons, e_{4A} and e_{4B}, are liberated. These then are also attracted to the plate.

In the meantime, the original electron, e, after having "ionized" atom 1, has been deflected somewhat from its original course but still under the influence of the positive field, has travelled to atom 2 where a similar action has taken place. As a result, electron e_2 has been liberated, which then collides with atom 3 where the process is again repeated. The original electron, e, again has gone on and ionized atom 5.

Further explanation is unnecessary. It should be apparent that though only one electron left the cathode, as a result of its successive encounters with atoms and the consequent liberation of new electrons, *not one, but seven* electrons finally reach the plate. It also must be evident that a tube in which this action occurs will carry currents of far greater magnitude than tubes without gas and in which this disruption of atoms does not occur. For electrons are "carriers" of electricity and the greater their number, the greater the magnitude of the current.

The production of these additional electrons, however, is not the only effect of ionization. What, one may ask, becomes of the residue of the atom?

The answer to this question is relatively simple. An atom, after losing an electron, is positively charged and it will migrate toward the cathode which is negatively charged with respect to the plate. The atom, however, may be thousands of times more massive than the electron and since its charge is no greater, the speed of its migration toward the cathode will be slow, so slow in fact that this drift of positively charged elements contributed little towards increasing the magnitude of the current.[5] It has an important effect, however, in that it neutralizes part of the negative "space" charge which surrounds the cathode and which, in high vacuum tubes, limits the transportation of electricity from cathode to plate.

The subject of space charge is one of great importance in electron tube phenomena and a detailed discussion of it will be presented in a later chapter. A brief consideration of it here, however, will be of advantage, not only because it will aid in understanding the action of the gas filled tube, but it will also serve as an introduction to the more detailed discussion to follow.

Space Charge

Briefly, space charge is the resultant negative charge of all the electrons in the immediate vicinity

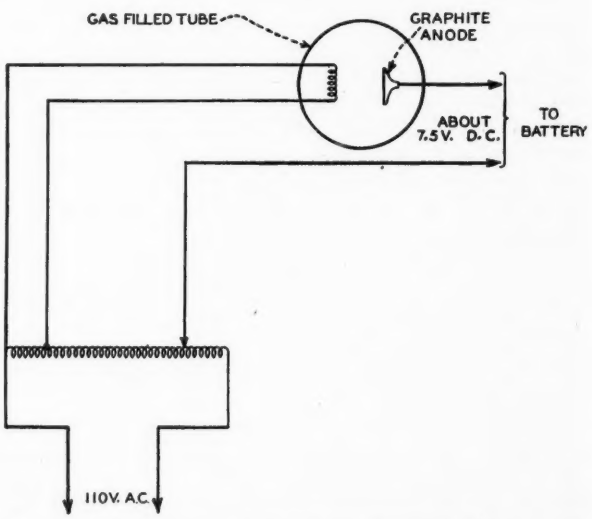


Fig. 5. Wiring connections of a simple "Tungar" or "Rectigon" battery charger

of the cathode. In Fig. 4 is depicted the relative distribution of electrons around a cylindrical thermionic cathode placed at the center of a cylindrical anode. The density of electrons, it will be noted, is very much greater in the immediate vicinity of the cathode than it is at distances further removed, in fact the cathode is surrounded by a virtual "cloud" of electrons. This

[5]A conception of the order of atom, electron and ion speeds is given by E. D. McArthur of the General Electric Co. in his book Electronics and Electron Tubes, as follows: 1. The mean speed of a mercury atom in a container at a temperature of 60 deg. C. is 0.12 miles per second. This is the ordinary molecular speed due to temperature. 2. The speed of an electron after being accelerated by a potential difference of one volt is 368 miles per second. 3. Under the same difference of potential, (1 volt) however, the speed of the mercury ion after being accelerated, is only 0.6 mile per second.

cloud, by virtue of its negative influence, exerts a repelling effect upon other electrons tending to emerge from the cathode surface. This action holds for high vacuum type tubes as well as those containing gas.

The effect of this cloud of electrons is usually referred to as the space charge and its presence constitutes a limiting effect upon the space current through the tube. For it is evident that if there is a force tending to keep the electrons from emerging from the cathode, the electron current cannot attain the value that it would if this retarding influence were not present. Any method of reducing or neutralizing this space charge, therefore, will benefit the performance of the tube.

Understanding this, the function of the positive ions resulting from the ionization process described becomes evident. As the positively charged atoms approach the cathode, their fields neutralize the fields of the electrons and thus the space charge is partially neutralized. The greater the degree of neutralization, the more does it aid the emission process.

Thus, although the production of additional carriers (electrons) is an important effect of ionization in a gas filled tube, the more important effect is the neutralization of the space charge.

Practical Applications

The effect of introducing gas into thermionic tubes, therefore, is to enormously increase the current carrying capacity. In such tubes currents are measured not in micro- or milliamperes as in the case of high vacuum tubes, but in amperes and even hundreds of amperes in large power tubes. Such tubes (two element gas filled tubes) therefore, are used for rectifying alternating current for power purposes. The ordinary small battery charging rectifier such as the Tungar[6] and Rectigon[7] chargers use tubes of this type. These tubes are characterized by a heavy tungsten filament acting as a cathode heated to a very high temperature to make it yield very high emission; about ten times that obtainable in high vacuum tubes. Enough argon gas is admitted to the tube to prevent evaporation of the filament at this high temperature.

The circuit of such a battery charger is shown in Fig. 5. 110 v. a.c. is supplied to a small auto-transformer which supplies both the filament current and the plate. Only a very low voltage is necessary for the filament (1.8 v.) so only a few turns of the transformer are used to supply this voltage. This circuit, of course, provides half wave rectification. For full wave rectification, two tubes are used in a circuit such as shown in one of the preceding articles.[8]

While the introduction of gas into a thermionic tube greatly increases its current carrying capacity, it at the same time so alters the characteristics of the tube as to make its application quite different from those of the high vacuum type. Thus far we have only considered the use of gas in two element tubes, and in these tubes the use of gas has not altered its function materially, such tubes are still rectifiers as is the high vacuum two element tube. When we come to discuss three element gaseous tubes, however, we shall see that the presence of gas entirely changes the functions of the tube and adapts it to an entirely different set of purposes.

Because of the use of gas in a two element tube so greatly increases its current carrying capacity, it adapts the tube to power purposes. Indeed, the well-known mercury arc rectifier used for many years in the railway field is a tube which operates on these same principles except that the electron emission is obtained not from a heated cathode but from a pool of liquid mercury. If an arc is formed between such a pool and another electrode, a "cathodic" spot is formed which furnishes an intense source of electrons.

Other forms of mercury vapor rectifiers use hot cathodes just as the "Tungar" and "Rectigon" tubes described, but these tubes instead of being filled with

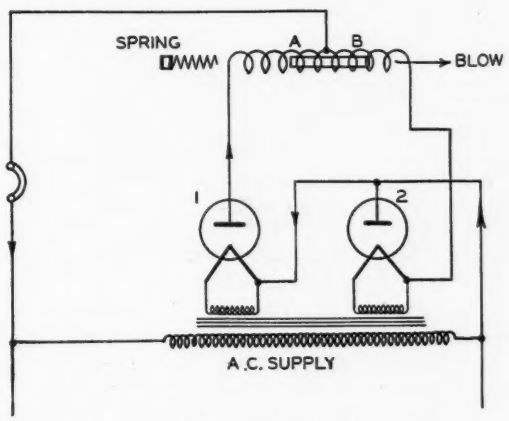


Fig. 6. The Syntron Electric Hammer

argon are filled with mercury vapor. During manufacture, after being thoroughly exhausted, a small quantity of mercury is placed in their interior. Later, when in use, as the cathode is heated, this mercury evaporates and the tube fills with mercury vapor, at a pressure which depends directly upon the coolest part of the tube's walls. At the coolest spot on the wall the mercury vapor condenses; hence the temperature of this spot is the principal factor which controls the pressure to which the mercury evaporates.

In the case of mercury vapor tubes the voltage required to ionize the mercury is 10.4 volts. The actual voltage maintained across the tube in practice is about 15 v.

Gas filled, or "gaseous," tubes as they are known, have become an extremely important part of the electron tube family. In less than fifteen years their use has been extended from the simple battery charging application referred to, to almost every branch of industry and electrical engineering. In the conversion of alternating current to direct and in the "inversion" of direct into alternating current, they have become indispensable.

In performing the comparatively simple function of rectification they have made possible many interesting and useful industrial devices. Consider the one shown in Fig. 6, for example.[9] This circuit is used in

[6]General Electric.
[7]Westinghouse.
[8]Part III—Page 230, April 1936 issue.

[9]Electrons at Work—Underhill.

(Continued on page 419)

Linemen Brave Blizzards to Maintain Service

By C. W. GEIGER

WITH 10 FT. OF SNOW within 5 days at Buck's Creek hydroelectric power plant in the Feather River country in California, with 8 ft. previously on the ground, a total snow fall of more than 36 ft. in the upper stretches of the South Yuba River, 9 ft. 9 in. of packed snow at Twin Lakes, El Dorado County, and 7 ft. 3 in. at Lake Spaulding in Nevada County, the linemen who maintain the electric power lines in these areas have had their hands full during the past winter. It is difficult to imagine conditions such as this in these July days, but this is only part of the story. Add to these heavy snow falls a 55 mile gale with the snow impinging like sand from a pneumatic gun and with the ground covered in many places to depths of at least 12 ft. and snow drifts 30 ft. high and you have some picture of the hardships which the linemen in those regions encountered.

These, however are typical of the obstacles that the Pacific Gas & Electric Co. linemen have to overcome every winter to maintain service in 46 counties for the company's 760,000 electric consumers. This year the company's toughest job was in the Feather River region where 10 ft. of snow fell in 5 days. It was wet, heavy snow and packed around the wires to a thickness of 8 to 10 in. As a result of this unusual load, there were 25 separate breaks in the 40 or 50 mile circuits between the Caribou power plant and Quincy, Calif. That this extensive damage was fully repaired in less than 48 hr. is splendid tribute to the fine work of the linemen. Even with skis or snowshoes the linemen could hardly move through the deep snow. They had to carry the equipment on their backs because tractors were powerless.

Fig. 1. Linemen working in Sunny (?) California

Fig. 2. Linemen wearing snowshoes and skis and carrying equipment for making repairs

In one instance a severe blizzard precipitated a crisis on the Eureka Canal in Tuolumne which carries the domestic water supply of Tuolumne, Soulsbyville and Twain Harte. While the snow was falling at the rate of almost 5 ft. in three days, a terrific wind blew several trees into the flume and threatened to clog it up. Seventeen Pacific Gas & Electric Co. workers and 20 unemployed men were pressed into service and labored from dawn to dark for 10 days to clear out 14 miles of the canal.

During a blizzard in the Sierra summit two linemen floundered about on skis at one o'clock in the morning trying to make their way back to the highway and their truck after taking care of a necessary repair job on a 60,000 v. power line. They could not see 20 ft. ahead of them although they carried a special searchlight with a 500 ft. beam. It was impossible for them even to get their bearings from an airway beacon which they knew was only a rod or so away because the storm blotted out its powerful rays. Often they fell into soft spots and sank to their arm pits. Once it took half an hour to get back on a firm footing.

To make a long story short, it took this pair of linemen more than two hours to reach the truck three quarters of a mile from where they had been working.

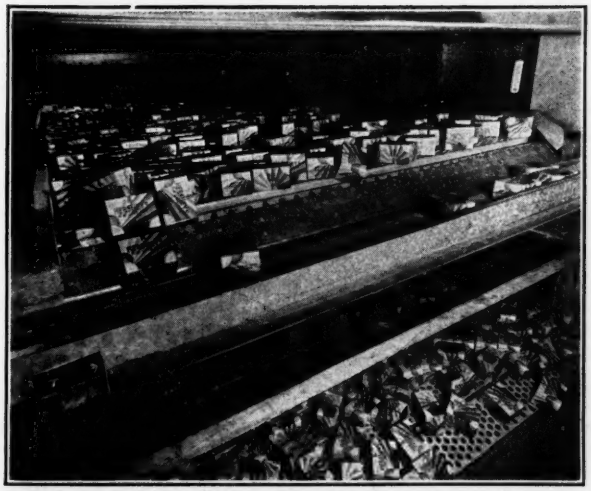
A terrific storm in Shasta County kept several gangs of linemen on the job for 72 hr. at a stretch. Snow froze to the power cables until they were 8 or 9 in. in diameter. Finally a 60,000 volt line snapped under the strain, then two more. Out went all the men available in both Shasta and Tehama counties, driving in blinding snow over icy roads. Once on the job the men forgot the clock and toiled until service was restored. As if that was not enough, the Pacific Gas & Electric Co. telephone lines were broken in 26 places. This meant more work for the crews because telephones are essential in operating electric power systems.

Booster Compressor *cuts* Power Bills

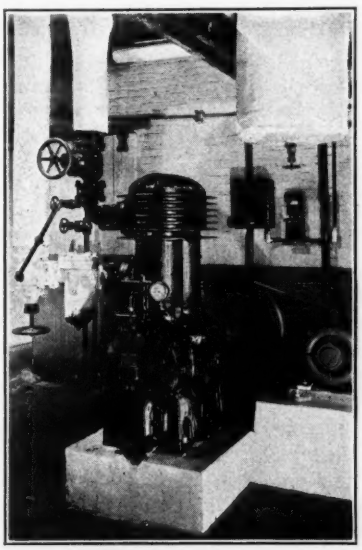
IMPROVING an already modern plant is not easy, yet it can be done by careful scrutiny of processes as has been demonstrated in the ice cream plant of the Hershey Creamery Co. at Harrisburg, Pa.

As the demand for packaged ice cream grew, the problem of handling the thousands of cartons in the hardening rooms became a serious one. Even though these rooms were carried at 20 to 25 deg. F. below zero, it required up to 48 hr. for the ice cream in the packages to become solid, in the center of the stack. To spread these packages out sufficiently for the cold air to circulate between them would have required a tremendous floor space. Realizing at the same time that operation of the entire refrigerating system on a suction pressure low enough to carry these temperatures was very wasteful, the management decided to split the refrigeration load, and to install a booster ammonia compressor for handling the low temperature work.

For quick hardening the packaged ice cream, an insulated tunnel 10 ft. sq. was built and equipped with two sets of chain conveyors as shown in the illustration. The temperature in this tunnel is maintained between 40 and 50 deg. F. below zero by means of bunker coils of a special flooded type, over which a blast of air is circulated at 1800 f.p.m. by a pair of fans at each end. The conveyors are 45 ft. long, and their speed averages 1 ft. per min., though this can be varied to suit requirements. The ice cream is thoroughly hardened in one passage through the tunnel.



Conveyors handle the packages in the hardening tunnel



Booster Compressor

Packages come into the tunnel on a belt conveyor from the packaging machines and are swept from the belt conveyor to the chain conveyor by an arm under automatic electric control. Another set of belt conveyors at the opposite end of the tunnel carry the cartons through the bulk hardening room to the packaging table where they are put into larger cartons holding 2 gal. each. These cartons are then stacked in the main hardening room, which is now held at a temperature between 10 to 15 deg. F. below zero.

During the past season the tunnel handled 30,000 packages a day, but this capacity is at present being increased by a second booster compressor. The original booster machine has two cylinders, each 8¾ by 6 in., and is driven by a 10 hp. motor. This machine is connected to 7,000 feet of 1½-in. pipe coils in the bunker space above the quick-hardening tunnel.

The booster machine discharges to an intercooler, consisting of a shell inside of which is a coil for cooling the liquid ammonia being fed to the evaporators in the tunnel. A bath of liquid ammonia surrounds these coils inside the intercooler and the gas evaporating from this bath emerges with that coming from the booster machine to cool it to a saturated condition. From the intercooler the ammonia goes to the main suction line leading to the four large enclosed-type compressors which formerly carried the load. These improvements in the refrigerating system were worked out in cooperation with engineers of the Frick Company of Waynesboro, Pennsylvania, which firm is now installing a new 11½-in. by 8-in. booster machine to extend the low temperature operations of the creamery company.

Seals *against* Fluid Pressure

Part III. Specifications for sheet packings used in the making of fixed joints

WHEN NECESSARY to make a fluid tight seal in a fixed joint between metal surfaces, the most commonly used packing is that manufactured in the form of sheets. When applied, the packing is cut to fit the contacting surfaces without in any way interfering with the correct flow of the fluid nor the bolts that fasten the parts together.

Sheet packing is particularly useful for irregular or unusually shaped joints for which manufactured gaskets are not conveniently available, because it can be cut to fit a joint at the time it is installed. As sheet packing is usually purchased by the pound or yard, economy demands care in the cutting of gaskets, to see that as much of the material as possible is used. Much waste can usually be avoided by cutting large gaskets first and using the left over insides and corners for the smaller gaskets.

In the selection of the packing used for gaskets, great care should be exercised to make certain that it fits the conditions under which the gasket is to be used, hence a study of the qualifications given here should serve to guide the purchaser in the selection of his sheet packing. The requirements which are here specified and the recommendations made are gleaned from United States Government specifications as used principally by the Navy but are applicable as well to stationary power plants. It will be recognized that only fundamental factors are treated leaving considerable leeway to the manufacturer whose product is up for consideration.

Rubber Packing and Gaskets: Molded, Sheet and Strip

Packings and gaskets made entirely of rubber compound are specified under three grades for uses similar to that in the Navy. Grade A is suitable for gaskets and packing for doors, hatches and similar services where the pressure is low, where common atmospheric weather temperatures prevail and where the fluid contained is such as will not deteriorate this rubber. Grade B is suitable for grommets to be used in packing gage glasses on tanks and for gaskets under plugs of various types. Grade C is for use in connection with cold water, hot water and temporarily for steam not exceeding 150 lb. pressure per sq. in.

It is assumed, of course, that the material and workmanship in all packings and gaskets will be free from defects. Rubber packing and gaskets must not contain oil substitutes and must be free from all substances which might injuriously affect the quality. In the compounding of this packing the minimum amount of rubber by volume as specified is: for Grade A, 80 per cent; Grade B, 70; and Grade C, 60 per cent; while the maximum specific gravity is: for Grade A, 1.55; Grade B, 1.65; and Grade C, 1.75. In physical characteristics this packing and gaskets must meet the requirements given in the following table:

Grade	A	B	C
Tensile strength, Min. lb. per sq. in.	2200	1700	1000
Ultimate elongation, Min.—in.	2-12	2-11	2-9
Set stretch for 10 minutes—in.	2-11	2-10	2-8
Set after 10 minutes' rest—per cent	20	25	25

It is required that the tensile strength of packing and gaskets after being subjected to an accelerated aging test of 96 hr. in air at 158 deg. F. plus or minus 2 deg. shall show a decrease from the tensile test obtained before aging of not over 25 per cent, unless the thickness of the test specimens is necessarily less than 0.05 in., in which case the loss in tensile strength shall not exceed 35 per cent.

Packing of Grades B and C must not be appreciably harder or softer than before steaming, nor shall it be otherwise injuriously affected after having been subjected to the following test: The sample is clamped between iron plates and exposed to the action of steam at 150 lb. per sq. in. pressure for 4 hr. The sample is then removed and allowed to cool for 1 hr. before submitted to physical tests.

It is essential that sheet packings are of uniform thickness and have a smooth surface; tolerances, however, are allowable as follows:

Thickness specified	Plus or minus tolerance
1/16 to 1/8 in. inclusive	1/64 in.
Over 1/8 to 1/2 in. inclusive	1/32 in.
Over 1/2 to 1 in. inclusive	3/64 in.
Over 1 in.	1/16 in.

Similar tolerances are allowable for strip rubber and gaskets. Rubber gaskets are molded, stamped, or cut from tubing as may be required, and of the shape, dimensions, and within the tolerances specified.

Rubber, Cloth-Insertion Sheet Packing

Sheet packing made of rubber, cloth-insertion, has been found suitable for flange joints in services handling cold water or brine at pressures up to 250 lb. per sq. in., also for ventilating systems. This packing may be obtained in two grades: Grade A being suitable for use where the joints are to be separated only at long intervals, Grade B where joints are to be separated at frequent intervals.

This packing consists of alternate layers of rubber and cotton fabric. Both faces of the packing may be of rubber or fabric as desired, but the layers of rubber should be of equal and uniform thickness. For each 1/16 in. in thickness of packing, there should be at least one ply of fabric. The fabric insertion is required to have 35 to 50 threads per inch in the warp and filling and weigh between 4¾ and 5½ ounces per square yard.

In thickness, a certain amount of tolerance is allowable, 10 per cent, plus or minus, being reasonable where the thickness is 3/32 in. or less, for greater thickness the allowable tolerance should not exceed 5 per cent. Accelerated aging tests recommended for this packing consist in subjecting it in air to a temperature of 158 deg. F. plus or minus 2 deg. F. for 96 hr., after which the decrease in tensile strength should not be more than 35 per cent of that before aging.

For Grade A packing, the rubber layers are required to be properly vulcanized and contain not less than 70 per cent, by volume, of the best quality new rubber. The acetone extract, corrected for free sulphur, must not exceed 7 per cent nor the total sulphur, exclusive of that contained in barytes, 8 per cent of the weight of the rubber as compounded. The following physical qualifications are required:

	Grade A	Grade B
Tensile strength, pounds per sq. in., minimum	1700	1000
Ultimate elongation, inches, minimum	2 to 11	2 to 9
Set, stretch for 10 minutes, inches	2 to 10	2 to 8
Per cent set after 10 minutes rest, maximum	25	25
Friction between rubber layers and fabric insertions, pounds, minimum	9	5

For Grade B packing the rubber layers are required to be properly vulcanized and must contain not less than 60 per cent of rubber, by volume, and no oil substitutes..

Rubber, Wire-Insertion Sheet Packing

As pressures and temperatures increase, greater strength must be given to rubber packings than that provided by cloth insertion. This may be obtained by substituting wire cloth for cotton fabric and packings of this sort are suitable for joints handling cold and hot water at pressures up to 300 lb. per sq. in. and temperatures to 250 deg. F.; for cold and hot brine at pressures up to 100 lb. and 250 deg. F.; and air and gases at pressures up to 200 lb.

Specifications are given for only one grade of this packing which is made of layers of rubber with brass wire insertion so arranged that both faces of the packing are layers of rubber. Specifically, the packing is built up of alternate layers of rubber and wire insertion, the layer of rubber being the same thickness on both sides of the wire. Packing 1/16 and 3/32 in. thick has one ply of wire insertion, while packing of greater thickness requires one ply of wire insertion for each 1/16 in. of packing thickness. The rubber layers contain not less than 60 per cent by volume of the best quality new rubber. The acetone extract corrected for free sulphur must not exceed 7 per cent nor the total sulphur, exclusive of that contained in barytes, exceed 8 per cent of the weight of the rubber as compounded.

Wire insertion for this packing is specified to be woven from brass wire 0.012 in. in diameter, 24 meshes to the inch. The tolerance in thickness, plus or minus, permitted is 10 per cent for 3/32 in. or less packing thickness, and 5 per cent for greater thickness. The weights should conform to the following limits:

Size of packing, inch	1/16	3/32	1/8	3/16	1/4
Weight of packing, pounds per sq. yd.—Min.	7.0	9.75	14.0	20.5	27.0
Max.	8.5	11.75	16.5	24.5	32.5

The physical tests required of wire-insertion rubber packing are: It must withstand bending double in any direction without cracking. It must stand exposure to boiling water for 4 hr. without apparent injury or separation of layers. It must stand bending 180 deg. around a rod of diameter equal to its thickness after exposure to steam at 150 lb. per sq. in. gage pressure for 4 hr. Its friction test must show that the rate of separation shall be not greater than 1 in. per minute under a load of 9 lb. per inch of width.

Compressed Asbestos Sheet Packing

Packing to which this specification applies is made in only one grade of asbestos fiber, rubber, sulphur and suitable mineral fillers, formed into sheets having smooth surfaces and free from imperfections. This packing is suitable for joints under such conditions as the following: Steam up to 300 lb. pressure and 700 deg. F. temperature; hot or cold water or brine up to 300 lb. pressure; high and low pressure air up to 3000 lb. pressure; gases of combustion up to 500 lb. pressure and 700 deg. F. temperature; fuel oil up to 500 lb. pressure and 250 deg. F. temperature.

This packing is required to be composed of asbestos fiber and a rubber compound thoroughly and evenly mixed, then pressed into a sheet of compact and uniform texture, either cross laminated or single ply. It must contain not less than 75 per cent by weight of asbestos fiber and not less than 10 per cent by weight of rubber. The asbestos fiber specified is "Chrysotile" and must contain not less than 12 per cent of water of composition, and the rubber compound must be free from all substances that might injuriously affect the quality.

In tensile strength, the packing is required to be not less than 4000 lb. per sq. in. except that single ply sheets 1/64 in. thick having a minimum tensile strength of 1800 lb. per sq. in. will be acceptable if the average tensile strength in the longitudinal and transverse directions is not less than 3000 lb. per sq. in. The tolerance in thickness which is permissible is plus or minus 10 per cent for thickness of ⅛ in. or less

and 5 per cent for greater thickness. The weight of this packing is required to conform to the following table:

Thickness, inch		1/64	1/32	1/16	1/8	3/16	1/4
Pounds per sq. yd., lb.	Min.	1.0	2.2	4.4	8.8	13.2	17.6
	Max.	1.3	2.7	5.4	10.8	16.2	21.6

It is required that the finished sheets shall be free from gasoline or other solvents used in the process of manufacture, and only when specified shall the sheet be graphited.

Packing conforming to this specification may serve the same purpose as special molded rings under such service as filling the packing space in boiler-blowoff valves since by using a number of rings of 1/16 in. packing the individual rings will vulcanize into one solid ring.

Asbestos, Metallic Cloth, Sheet Packing

Two grades of packing are specified to come under the heading of asbestos, metallic cloth, sheet packing. Grade I, containing not less than 90 per cent asbestos, is applicable to flange joints for: steam up to 300 lb. pressure per sq. in. and 700 deg. F. temperature; hot or cold water or brine to 300 lb. pressure; air to 3000 lb. pressure; gases of combustion to 725 deg. F. temperature. Grade II, containing not less than 75 per cent asbestos, finds use on flange joints for: steam to 200 lb. pressure and 500 deg. F. temperature; hot or cold water or brine to 200 lb. pressure; air to 200 lb. pressure.

This packing is made of woven asbestos wire insertion cloth treated with a rubber compound. Sheet packing 1/16 in. thick has one ply of cloth weighing not less than 2.75 lb. per sq. yd. before application of the rubber compound. Sheet packing 1/8, 3/16 and 1/4 in. thick has 2, 3 and 4 plies, respectively, of 1/16 in. cloth cemented together. The wire insertion is either of brass or copper, 0.007 in. in diameter, plus or minus 0.001 in. The weight of the finished packing must come within the following limits:

Thickness, inch		1/16	1/8	3/16	1/4
Weight per sq. yd. lb.,	Min.	5.50	10.50	16.00	21.50
	Max.	6.25	11.75	17.75	24.00

Tolerance in thickness of the sheet is permitted in the plus direction only to the extent of 1/64 in. The finished packing when tested for bending must not crack nor show any signs of injury when bent flat on itself in any direction.

Grade I is woven from yarn containing not less than 90 per cent, by weight, long fiber asbestos of not less than 12 per cent, by weight, water of composition. It is not less than 20 strands in the warp and 10 strands in the filler per linear inch. Each strand of warp and filler consists of two plies of asbestos yarn and one brass or copper wire twisted together. The rubber compound must not be more than 50 per cent by weight of the finished packing. The packing must not show signs of flowing, cracking, material hardening, or disintegration of the rubber compound when subjected to the action of saturated steam at 275 lb. pressure per sq. in. for a total of 24 hr.

Grade II is woven from yarn containing not less than 75 per cent, by weight, long fiber asbestos of not less than 12 per cent, by weight, water of composition. The weave of the cloth consists of not less than 16 strands in the warp and 8 strands in the filler per linear inch. Each strand of the warp and filler consists of two plies of asbestos yarn and not more than two brass or copper wires twisted together. The rubber compound must not be more than 55 per cent, by weight, of the finished packing. This packing must not show signs of flowing, cracking, material hardening, or disintegration when subjected to the action of saturated steam at 200 lb. pressure per sq. in. for a total of 24 hr.

Hard Fiber Sheet Packing

Packing designated as hard fiber sheet packing is suitable for gaskets in connection with water, lubricating oil, and air connections of internal combustion engines at pressures up to 200 lb. per sq. in. where the temperature does not exceed 150 deg. F. and in connection with carbon dioxide gas up to 1500 lb. per sq. in. pressure. The specification permits only one grade of this packing which is commercially known as B.H. or "bone hard."

This packing is composed of pure cellulose, free from any appreciable amount of chloride of zinc or mineral matter. It is essential that the packing shall be clean, hard and straight, with smooth surfaces, and free from cracks, seams, blisters, flaws, tears, creases, and grains or other defects. It is required to be uniform in color, texture, density and thickness; the gray or natural color being usually preferred. The Brinell hardness must not be less than 15 and the specific gravity not less than 1.30. In determining thickness, the average of five measurements must be within the following tolerances:

Thickness, inch	1/32	1/16	3/32	1/8	3/16	1/4	3/8	1/2
Tolerance, plus or minus, inch	0.005	.007	.008	.010	.012	.012	.012	.015

Tensile strength in pounds per square inch must conform to the following:

Up to 1/8 in., inclusive—Crosswise...6500—Lengthwise...8500
Over 1/8 to 1/2 in. Crosswise...6000—Lengthwise...8000

Of extreme importance is the water absorbing characteristics of this packing which must not exceed the following values, given in per cent by weight:

Up to 1/16 in., inclusive.....45
Over 1/16 to 1/8 in.....20
Over 1/8 to 3/8 in.....10
Over 3/8 to 1/2 in..... 5

The water absorption test is made with apparatus consisting of a good chemical balance and a beaker of distilled water. The test specimen is 2 in. square and the thickness of the material. All surfaces and edges are to be smooth and free from burrs. After conditioning the specimen by subjecting it in air to a temperature of 217 deg. F. for 20 hr., it is weighed, the result being designated as weight 1. The specimen is then placed in distilled water for 1 hr. and, on removal, wiped dry of all surface water and immediately weighed, giving weight 2. The temperature of the room and water are kept at 75 deg. F., plus or minus 10 deg. Then:

$$\frac{\text{Weight 2} - \text{Weight 1}}{\text{Weight 1}} \times 100 = \text{per cent water absorption}$$

Only one grade of packing comes under the spec-

ification given here for fiber packing for lubricating and fuel oils, this being suitable for joints subjected to the following conditions: Gases of combustion up to 500 lb. pressure per sq. in. and 120 deg. F. temperature; gasoline and fuel oil up to 300 lb. pressure and 120 deg. F. temperature.

This packing is made of plant fiber and glue or other suitable binder, it has smooth surfaces and must be free from imperfections. It is rolled or compressed into sheets of compact and uniform texture; it contains no rubber, asbestos or any material affected by oil or water, and must not contain more than 15 per cent moisture. The required minimum tensile strength in either direction is 3000 lb. per sq. in. and it must be sufficiently flexible to be capable of being bent around a rod the diameter of which is equal to twice the thickness of the sheet, without cracking or breaking.

Sheet packing of this grade 1/16 in. thick should weigh not less than 2.6 lb. nor more than 4 lb. per sq. yd., other thicknesses being in proportion. In thickness, the plus or minus tolerance allowable is: for 1/8 in. or less, 10 per cent; greater thickness, 5 per cent.

(To be continued)

Foreign Substances in Boilers

By C. C. CUSTER

THE BOILER INSPECTOR sometimes finds that not all foreign substances get into boilers through the feed line. A few typical cases will explain,—

1. A tank car of heavy fuel oil was delivered on a spur track next to an industrial plant where they operated their heating boilers with oil. Heavy fuel oil gets so stiff in zero weather that it cannot be pumped unless first heated. For this reason some tank cars are provided with steam coils so that the oil may be heated by steam. A steam hose was run out the basement window from the boilers in the basement and attached to the steam coil and the work of pumping went on. The job not being finished by quitting time the men went away leaving the hose in position without shutting off the steam. It seems that the steam coil in the tank leaked, for when the steam went down in the boiler that night and a vacuum was formed on top of the water in the boiler it sucked some oil back into the boiler from the tank car and when they started the boiler in the morning they had a case of violent foaming of water in the boiler. They had to boil the boiler out with caustic soda to remove all traces of the oil. Many cases of bagging of boilers have occurred from oil or other impurities getting into boilers in a similar way.

2. A couple of young lads embarked in the business of making cheap laundry soap, quite a bit of steam being used in the process work for both heating the caustic soda or lye solution and also for boiling the soap grease before turning the solution together, or however they do it in making soap. The boys built a steam line of small pipe over to the tanks with only a stop valve in the line and after using it they forgot to turn off the stop valve at night, the steam already having gone down. They did not realize that a vacuum would be formed back in the boiler so that the next day they had quite a bit of soap grease and also lye back in the boiler, which was not a good mixture as they bagged their boiler,—that is, one of them (they had two small boilers). They changed over to the other boiler. But luckily before they burned it likewise, the boiler inspector came along and showed them where their trouble was and suggested check valves in the lines going to the vats.

3. A few weeks ago the writer went to inspect a small vertical tubular boiler which was making its first trial run in a little plant being put up for regalvanizing the dairymen's old milk cans to make them like new. The cans were first put into a pickling vat to remove the rust and dirt and then they went into the vat where the galvanizing was applied.

The pickling vat contained muriatic acid,—the galvanizing vat had in it some tin or zinc in solution. It was necessary to turn steam into both vats to hasten the action of the chemical operations. In this case there were separate steam lines run to each vat being tapped out from opposite sides of the boiler and in the lack of check valves in the lines they were occasionally getting both kinds of impurities back into the boiler when they turned out the gas fire under the boiler during the noon hour or at quitting time in the evening when they forgot to turn off the steam valves.

This kind of a typical accident, the boiler inspector runs across every now and then. It happens often where there are jacketed vacuum kettles used for process work in canning factories. When the jacketed kettle springs a leak on its cooking side the condensation handled by the vacuum pump may put almost anything from catsup to treacle back into the boiler to its detriment.

Electron Tubes

(Continued from page 413)

the operation of the "Syntron" electric hammer for drilling holes in concrete at high speed and for similar purposes. Currents in two solenoids alternately and periodically act on a common steel core to pull it to and fro in synchronism with the alternating current in the line. "Tungar" or "Rectigon" rectifiers are employed to change the alternating current into pulsating current. When the voltage pulse is negative on the right hand side of the circuit, the electron current flows through tube 1 and coil A and the steel core or plunger hammer is pulled in that direction to compress a spring. On the reverse voltage swing, the electron current flows through coil B and the plunger hammer is pulled in that direction as it is simultaneously pushed by the spring, thus causing it to strike a sharp blow—60 times a second on a 60 cycle circuit.

N. D. H. A. Radiates Optimism

Twenty-seventh Annual Convention in Grand Rapids, June 16 to 19, visions bright future for industry. Registration over 160. M. D. Engle new president

BUSINESS gains during the past year, a membership increase of some 17 per cent and a sound financial policy which has again placed the society on a cash basis, combined to produce a tone of optimism which bids fair to carry the National District Heating Association to new heights. For the first time in several years committee reports were preprinted, thus allowing more free and comprehensive debate and discussion from the floor. Present plans call for publication of the complete proceedings late in the summer or early in the fall.

Problems still remain, as they always will in any highly competitive business, but the report of the Sales Committee Chairman, J. J. Tennant, Pittsburgh, Pa., pointed out a definite trend from defensive to offensive selling. It also outlined plans for an intensive training course for salesmen which was enthusiastically received by the convention. This course should coordinate the effectiveness of sales efforts not only toward expansion but also toward closer cooperation within the association and within individual organizations.

Efforts of this committee are being ably and enthusiastically backed by the Commercial Relations Committee, L. S. Phillips, New York City, chairman, in keeping customers satisfied. New temperature controls, better methods of utilizing steam and the handling and forestalling of complaints were covered by the report. The committee is revising or rather rewriting the "Principles of Economic Heating," an educational primer for the steam heat customer and probably the most widely used publication in the industry for the past six or eight years. The widespread interest of members in this as evidenced by discussion and criticism should be a source of no little satisfaction to the committee. Reports of this kind have a tendency to be the work of a few, often but one man, and the welding of severe criticism into a means of making the report representative of the entire association rather than a small committee might well be studied by future committees. The graceful acceptance and utilization of criticism is perhaps the result of the chairman's past experience in satisfying disgruntled customers.

Opening Session

The convention was welcomed to Grand Rapids by D. E. Karn, vice president and general manager of the Consumers Powers Co., who indicated a new field for the industry through the sale of high pressure steam and closer industrial cooperation. In response, M. D. Engle, Boston, Mass., called attention to the enviable record of the Consumers Power Co. system in Grand Rapids where over a period of some 40 yr. steam has never been off the system during the heating season.

President R. L. Fitzgerald, Duluth, Minn., traced the progress of the association during the past year and called particular attention to the need for a steam transmission committee to deal with this rapidly increasing problem of high pressure steam transmission. Russia has built plants at the peat bogs to dry peat and make gas for burning under boilers. Some 3,000,000 kw. annually are generated at and transmitted from these plants and there is a possibility that the billions of tons of peat in Minnesota might be handled the same way or through long distance steam lines with reheat stations to the point of use.

In space heating circles the degree day, although widely used, is still subject to controversy and the Educational Committee, D. S. Boyden, Boston, Mass., chairman, is cooperating with other societies for further standardization. As a result of an intensive membership drive the membership committee, R. McNee, Boston, Mass., chairman, reported a gain of 66 new members. The Insurance Rate Committee, S. S. Sanford, Detroit, Mich., chairman, feel that the maximum of 5 per cent reduction now allowed for district heating customers on insurance rates should be increased. A recent investigation indicated that in fires of known origin 27 per cent occurred from heating equipment. The committee is cooperating with other interested agencies in promoting further reductions and a national recognition of the problem.

A. D. Leach, Portland, Ore., chairman of the Operating Statistics Committee, reported a general increase in building occupancy and an increase in connected load in all but the Mountain District. In the Pacific area the connected load increased over 4 per cent and in the Southern and Eastern Districts over 2 per cent. The average in the Central District was 1.44 per cent, although one company there reported the largest individual gain of 11.26 per cent. The Hot Water Committee, F. L. Witsell, Toledo, O., chairman, prepared no report this year. At this same session, H. C. Kimbrough, Chicago, Ill., chairman of the Manufacturers Committee, reported a complete sellout of exhibition space and reviewed briefly the 13 exhibits prepared by the following exhibitors: American District Steam Co.; E. B. Badger & Sons Co.; Bailey Meter Co.; Barber-Coleman Co.; The Bristol Co.; Central Station Steam Co.; Crane Co.; Minneapolis-Honeywell Regulator Co.; Jas. P. Marsh Corp.; The Ric-Wil Co.; Spence Engineering Co.; United States Steel Corp.; Warren Webster & Co.

Distribution and Meters

Several questions were covered by the Distribution Committee, G. D. Winans, Detroit, Mich., chairman, during the past year. The erratic growth of many distribution systems has made necessary the development of methods for increasing the capacity of certain sections by connecting high pressure feeder lines at certain points. Manual, remote and automatic equipment is used in this service. In some cases desuperheating is necessary to protect the older low pressure systems against excessive expansion.

Due to geographic or service conditions it is sometimes necessary to drain condensate against the flow of steam and in these cases the only satisfactory procedure is to install sufficiently large drip pockets and traps. One test showed that in a line with a 4 in. pitch condensate was carried upgrade at the surprisingly low velocity of 8000 ft. per min. and led to the decision to install drip pockets at high points of dead ended lines. Discharge from traps causes little trouble, in some cases high pressure traps discharge to low pressure mains to save the flashed steam. Reduction in underground construction costs are imperative but due to varying conditions little standardization has been made above this line in different sections of the country.

Widespread application of temperature controls, many of which operate on a short line cycle from zero to full load has intensified the problems of the meter engineer and led to increased activities of the Meter and Accessory Committee under the chairman, W. W. Stevenson of Pittsburgh. Many of the companies have testing laboratories and are at the present time carrying on tests on both fixed and variable orifice meters. To familiarize all members with the present status of the orifice meter, the committee arranged for Prof. S. R. Beitler to present a paper "Orifices, Orifice Coefficients and Orifice Meters."

Work carried out at Ohio State University for the past 30 yr. has given a thorough background for the accurate calculation of coefficients for the primary element or orifice. Prof. Butler presented data to show that except for extreme orifice ratios, coefficients for steam flow could be calculated from hydraulic data with negligible error. In a written discussion R. J. S. Piggott said that orifice meters should not be used for flows of less than 10 per cent of the maximum and that pressure and flow fluctuations were difficult if not impossible to compensate for conveniently.

Steam Station Engineering

This committee, headed by A. R. Mumford, New York City, concentrated its activities on operating problems and presented in brief six developments recently put into practice. R. G. Filger, Detroit, Mich., described a new spray type deaerating heater installed in the Congress Street Station last summer. Operating results show practically zero oxygen and a decided lowering of the CO_2 content. At Boston, the Minot St. plant, faced with the failure of a closed feedwater heater, converted it into a satisfactory spray type open heater which reduces the oxygen content to less than 0.1 c.c. per liter. This was described by Geo. C. Eaton who went on to tell briefly of the use of blowdown and sulfate metering at Kneeland Street Station, calibrated so as to match the steam flow meters.

Dust and steam from quenching in the ash cellar of the Burling Slip Station was eliminated according to H. J. Bauer by providing hoods vented to the stack. At Kips Bay Station a water loss of 10,000 cu. ft. a day from the heater due to faulty operation of a float operated heater valve at closed or nearly closed position was stopped by substituting a hydraulically operated valve with the pilot valve actuated from a float. This was told by Howard Goellner while Thomas Ravese of the same station described a thermocouple installation with 36 points on each boiler so connected through a plug board to a multipoint recorder that a complete test can be carried out in a few minutes. Effective paralleling of six steam driven feed pumps in this station was accomplished according to A. A. Markson. Hydraulic loading on the regulators replaced the spring loading. This pressure is taken from a bypass connection between the first and last stage. It is first adjusted by hand and then varies with the load to give greatly improved pump operation.

High pressures and high temperatures combined with power generation offer the district heating industry new fields according to Henry Kreisinger of the Combustion Engineering Co. Superimposed plant is particularly well adapted for industrial districts where considerable steam is used throughout the year. Data was presented to show the heat economy of the latest 1200 lb. 900 deg. F. non reheat cycle over previous reheat practice. M. D. Engle of Boston felt that past experience with reheat justified its existence and proved definitely that reheat difficulties and complications had been over-exaggerated. George C. Daniels of Jackson said that although top plants offer possibilities, their application is definitely limited not only by power and steam load requirements but by the condition of existing equipment as well. Not all old plants can be economically rejuvenated this way.

Water conditioning in high pressure steam plants was discussed at considerable length by R. E. Hall of Hall Laboratories, Inc. The four major divisions of the subject, prevention of scale, carryover, corrosion and metal cracking were outlined and the conclusion reached that although all the present problems are new since 1920 the water treatment art has kept pace with the industry. Those existing problems that have not been solved are at least under control and the close cooperation of the boiler manufacturer, consulting engineer, plant operator and water conditioning organizations will give speedy solution to new problems as they arise.

Research Committee

Activities of this committee, G. K. Saurwein, Cambridge, Mass., chairman, have been largely confined to the application of the steam jet to air conditioning for the purpose of increasing the summer steam load. The installation at Rockefeller Center has been improved considerably in economy. Results of tests made in this connection were reported by A. A. Markson and R. Mercke of New York in a paper, Testing of Steam Jet Coolers Under Artificial Loads. Application of this data to the design of a more economical control by means of water flow measurement was described in a second paper by J. M. Spenzel of Rockefeller Center. This new control substitutes for the usual water temperature control, a flow control which takes advantage

of the jet characteristics which gives increased thermal efficiency with higher chilled water temperatures at light load. From the standpoint of wider use, the economic application of steam jet cooling units was discussed by M. A. Nelson of the Westinghouse Elec. & Mfg. Co.

In reporting test results on a 12 in., 400 lb., 450 deg. F. steam line, 8000 ft. long, Claude R. Erickson, Lansing, Mich., reported a calculated expansion coefficient for the seamless open hearth steel pipe used of 0.00000686 which agrees well with the value of 0.00000688 from the Smithsonian Physical Tables. The conclusion was reached that in a line with well designed and maintained slip joints, rollers and guides that pipe elongation may be calculated as pure linear expansion due to temperature.

Under the chairmanship of John M. Arthur, Jr., Kansas City, Mo., the Rate and Regulations Committee made an unusually complete report made possible by a 100 per cent return of the questionnaire. The 25 companies reporting have 50 separate rates of which 37 are of the block type and 13 of the demand type; 64 per cent of the companies have a fuel adjustment rider on the contract and 72 per cent bill their customers gross and offer a discount for prompt payment.

Officers

New officers elected for the following year are: President, M. D. Engle, The Edison Elec. Ill. Co., Boston, Mass.; First vice president, T. E. Purcell, Allegheny County Steam Heating Co., Pittsburgh, Pa.; Second vice president, J. R. McCausland, Philadelphia Elec. Co., Philadelphia, Pa.; Third vice president, G. D. Winans, The Detroit Edison Co., Detroit, Mich.; Executive Committee: Edward Lenz, New York Steam Corp., New York City; F. L. Witsell, Toledo Edison Co.; R. L. Fitzgerald (retiring president), The Duluth Steam Corp., Duluth, Minn.; Mr. Sanford, secretary of the Philadelphia Engineers Club, has been appointed Secretary-Treasurer to fill the vacancy left last year by the resignation of D. L. Gaskill. Headquarters of the association will be moved immediately from Greenville, O., to Philadelphia, Pa.

Dairy Plant Refrigeration

A Highly Organized Industry Depends to a Large Extent on Modern Refrigeration Equipment. By J. T. Winslow, Assistant Engineer, Meadow Gold Dairies, Pittsburgh, Pa.

FLEXIBILITY AND SENSITIVITY are the keywords for the refrigeration system in a modern dairy plant operating seven days a week, every week of the year. Sensitivity is accomplished by proper application of the compressors with respect to load while flexibility is accomplished by ample compressor capacity.

Dairy products depend greatly on proper refrigeration, in the correct amounts, for quality and uniformity. It is therefore fundamental that the engine room satisfies each and every demand exactly when it is required. If the various degrees of cold are not available the milk, cream, buttermilk, eggs, butter, cheese, and ice cream do not maintain uniform quality and flavor. A customer in the present day knows enough about dairy products to appreciate a wholesome bottle of milk or cream.

To meet the demands of a large eastern milk and ice cream plant, the engine room has the following ammonia refrigerating machinery:

One York 6 by 6 in. two cylinder vertical s.a. ammonia compressor.

One York 7½ by 7½ in. two cylinder vertical s.a. ammonia compressor, Fig. 3.

One York 8 by 8 in. two cylinder vertical s.a. ammonia compressor, Fig. 3.

Two York 9 by 9 in. two cylinder vertical s.a. compressors, Fig. 1.

One Frick 10 by 10 in. two cylinder vertical s.a. compressor (double suction).

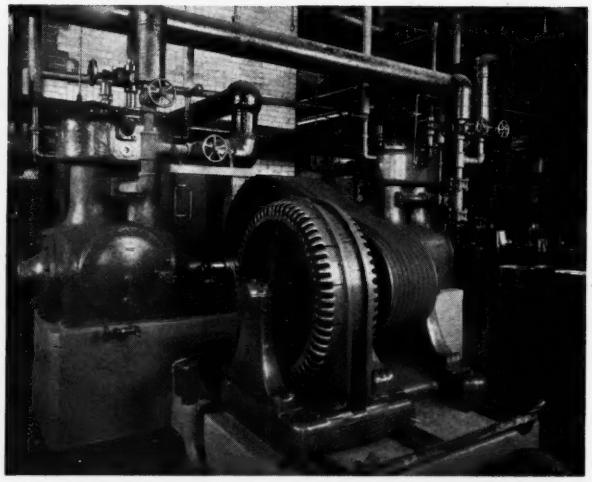


Fig. 1. Two 9 by 9 in. compressors driven by one 125 hp. synchronous motor. Other machines in the background

One York 11¼ by 8 in. two cylinder vertical s.a. booster compressor.

Two York 15 g.p.m. liquid ammonia circulating pumps.

Hot gas or discharge from the compressors (not booster machine) is condensed in three Vilter vertical, open type, shell and tube condensers (Fig. 2) each containing 151 two-inch tubes.

The condensers give 1087 sq. ft. of cooling surface. The condensing medium is water, circulated through the condenser tubes at a maximum rate of 800 g.p.m. The water, flowing by gravity through the tubes, is collected in a pit. From the pit the water is pumped over one or two atmospheric cooling towers, Fig. 2, as manufactured by the Cooling Tower Co. The smaller cooling tower is used to cool the condensing water in the cooler months, while the larger tower performs the

cooling operation in the warmer months. The cooling tower water drains into a trough and distributes itself by gravity to any desired combination of the three condensers. Make-up water to this cooling system is supplied by a float valve in the condenser pit. A battery of three centrifugal pumps circulate the condensing water. A Weinman centrifugal pump is rated at 800 g.p.m., satisfying the maximum demand while two smaller pumps, one a Pennsylvania Pump & Compressor Co. unit at 300 g.p.m., and the other a Dean-Hill at 200 g.p.m., satisfy the cooling demand in the winter or operate in an emergency.

The condensed or liquid ammonia is stored in two horizontal equalized receivers, Fig. 2. From the receivers the ammonia is piped to the various evaporating surfaces.

The three smaller ammonia compressors have sufficient capacity to at all times maintain the required suction pressures from the evaporators when sudden loads are applied.

Either of the large compressors, the 10 by 10 in. Frick machine or the two 9 by 9 in. York machines, Fig. 1, carry the large, more constant load. Both of these large compressors are driven by synchronous motors. The Frick compressor is direct connected to a 125 hp. General Electric synchronous motor, while the two York machines are belted with nine Dayton Cogbelts, Fig. 1, to another 125 hp. General Electric synchronous motor. The large compressors operate in the daylight hours when the load is greatest and when their synchronous motors can most advantageously correct the power factor for the large inductive load in the milk and ice cream plants.

The 11¼ by 8 in. booster compressor operates when large loads are being applied to our hardening room, but runs almost continuously in the warm months. The booster compressor is installed to handle the large volume of low pressure gas where it is impractical and uneconomical to pump the ammonia gas from evaporating pressure, 0 lb. to condensing pressure, 185 lb., in one stage.

Milk Plant Cooling

All refrigeration in the milk plant, with the exception of the milk storage cooler, is performed by calcium chloride brine. The milk cooler is refrigerated by four York blowers which draw the air over ammonia coils and discharge the cooled recirculated air through the cooler to maintain a 38 deg. F. temperature on an ever moving quantity of milk. The brine is refrigerated in York horizontal multi-pass shell and tube brine cooler, Fig. 4. The cooler is rated at 110 tons capacity and operates between 25 and 35 lb. suction pressure. One hundred fifty-seven 2-in. tubes result in 1316 sq. ft. of brine cooling surface. Through the brine system is circulated a maximum of 450 g.p.m. With normal conditions 300 g.p.m. is circulated, resulting in a 6 deg. F. cooling of the brine. The brine cooler requires a minimum of attention because it is float controlled and because the suction pressure of 30 lb. is maintained on the gages in the engine room. A battery of three centrifugal pumps circulate the brine to the various milk processing apparatus in the building. The capacity of one of the brine pumps, Pennsylvania Pump & Compressor unit, satisfies the load while two Westco pumps are operated only in case of an emergency or on "off-peak" loads, Fig. 4.

Safety measures have been applied to the brine system to prevent excessive pressures in the various milk processing coolers. Relief valves have been installed on the main feed line and on each of the pumps.

Ice Cream Plant Refrigeration

The ice cream plant cooling is more complicated in that it requires much more piping and operates on three different suction pressures. The ice cream hardening room contains 23,220 ft. of 1¼-in. black steel pipe. The overhead coils are arranged in twelve banks totaling 18,270 ft. of the 1¼-in. pipe or 7950 sq. ft. of evaporating surface. The coils are so located to give the maximum air circulation. The overhead piping is used to maintain a room temperature of 0 deg. F. to minus 10 deg. F. and operate at 0 lb. suction pressure.

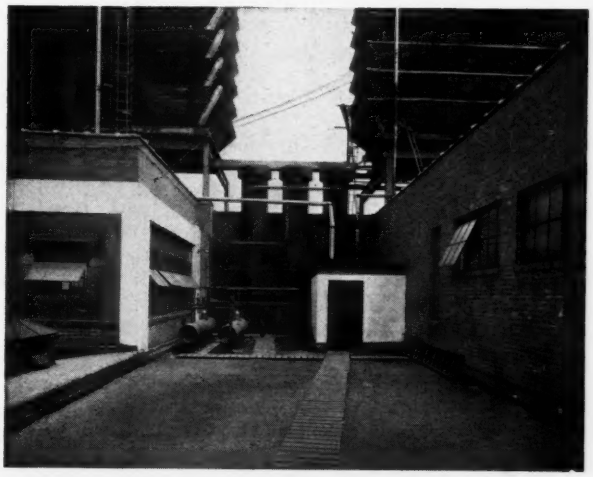


Fig. 2. Two cooling towers, three condensers and two receivers which serve the plant

Shelf or bench coils are arranged in three banks totaling 4950 ft. of the 1¼-in. pipe or 2155 sq. ft. of evaporating surface. The packaged ice cream from the freezers is rapidly hardened on the bench coils prior to the wrapping. The hardening room cooling system is completely float controlled with an additional liquid recirculating system. The liquid recirculation insures the utilization of all liquid ammonia.

The 0 lb. suction gas comes from the hardening room to a York low pressure receiver thence to the booster compressor. The booster compressor discharge gas (30 lb.) is first water cooled and then ammonia cooled. The booster discharge gas is now cooled sufficiently to enter into the 30 lb. suction line feeding the other compressors. Another suction line (0 lb.) comes from the hardening room and empties into a York low pressure receiver with the liquid ammonia entering either of two York liquid ammonia circulating pumps. The gas rises and passes to the booster compressor.

Ice Cream Freezing Room

The ice cream freezing room has one large Vogt continuous freezer supplying bulk ice cream in 2, 3, 5, and 10 gal. units. A smaller continuous Vogt freezer is used to provide ice cream for novelties and packag-

ing operation. The various ices, or sherbets, are made in a Cream-Pack batch freezer. Each of the three freezers use ammonia as the refrigerant. The freezing on the continuous freezers is automatically controlled by solenoid valves, while the batch freezer is hand-operated. Each of the three freezers operate on a five-pound suction pressure.

The second floor of the ice cream plant accommodates the so-called "high temperature" coolers, all operating on 30 lb. suction pressure. The ammonia expansion valves in these coolers are automatic, thereby preventing liquid carry-over into the suction lines to the compressors.

One of the high temperature coolers is equipped with 372 ft. of 2-in. pipe. Raw materials for the ice cream mix are maintained herein at 30 deg. F. Another cooler has 1248 ft. of 2-in. pipe maintaining a 35 deg. F. temperature for butter. A third cooler is maintained at 40 deg. F. to store cheese prior to consumption. The fourth cooler contains 1314 ft. of 2-in. pipe maintaining a 35 deg. F. temperature for a fast moving stock of eggs.

The ice cream mix room is provided with two 600 gal. Creamery Package refrigerated storage tanks to hold the incoming cream at its received temperature. The mix is pasteurized, filtered, viscolized, and passed over an ammonia-refrigerated cooler having 180 ft. of 2½-in. O.D. pipe. From the cooler the ice cream mix, at 38 deg. F., is pumped into any one of five 500-gal. Creamery Package refrigerated vats.

All the ammonia suction lines as well as the precooled liquid ammonia lines are covered with the proper thickness of Armstrong Cork pipe covering. The brine cooler, low pressure receiver and combined gas and liquid cooler are covered with Armstrong Cork logging.

To summarize, the compressors in the engine room are all cross connected so that any machine with the exception of the booster compressor may work on any one of the three suction pressures, giving infinite flexibility and sensitivity.

The Combustion Engineer

By N. T. PEF

I DO NOT KNOW the genealogy of the term "combustion engineer," who first used it or when it was first used but he must be one of the latest additions to the engineering profession. He is a child of the mass burning of fuel and is, therefore, a contemporary as well as complementary to the central station where he is found in practically every case, and many of the large industrial power plants also have combustion engineers in their power plant personnel. Another field for combustion engineers is in the manufacture of stokers and other boiler room equipment where they are employed in the installation, starting and testing of the equipment and sometimes as salesmen. In more recent years coal merchants have been interested in the services of combustion engineers and employ them in an advisory capacity to assist their sales forces.

A field that holds promising possibilities for the combustion engineer is the smoke abatement work in the large cities. At the present time there is considerable politics mixed up with smoke abatement, and securing a connection sometimes depends more on political pull than on knowledge of combustion, but as the public and business men take more and more interest in clean air, the combustion engineer who can accomplish real results in this field will find increasing opportunities. Some cities claim that they have made remarkable progress in smoke abatement work, and others admit that they have made little improvement in that direction. It is most likely that the latter condition is the one generally true while the former is the exceptional. This is not surprising considering the ignorance prevailing about smoke, not only among the public but also among those engaged in smoke abatement work. If a 50-hp. laundry boiler should emit black smoke for more than 5 min. the smoke inspector will be hot on his heels, but the stack next to it, although not smoky, may hurl more fly ash and other objectionable solids and gases into the air in one day than the laundry can do in a whole year and go unnoticed. The combustion engineer is in a position to know that a clear stack is not necessarily efficient and it does not necessarily do less harm than a smoky stack as judged by the eyes alone, that to go to the root of the smoke evil we must use not only our eyes, but also our brains. The first step towards success in any undertaking is knowledge of conditions. Most of the cities that have not had success in smoke abatement work probably have failed because they do not have the knowledge and it is for this reason that the combustion engineer can accomplish much public good and at the same time make for his own advancement.

But the combustion engineering field that demands the greatest initiative and offers the most promising reward to those who have the enterprise to undertake it, is the isolated power plant, especially the smaller one. Some of the larger industrial power plants have combustion engineering service, others can with advantage add a combustion engineer to their power plant personnel, but in the smaller ones the full time service of a combustion engineer will not be warranted. It is in this class of power plants that the combustion engineer has the opportunity for success that is limited only by his originality.

The system of combustion service most suitable for this field is that followed by a number of chemical engineers in the boiler water conditioning field, that is a common supervision of a number of power plants. Some work on this basis in combustion engineering is being done but taken by and large, the surface of this field has hardly been scratched.

Table of Latent Heat of Vaporization

By Fred J. Wiegand

CALCULATION of steam quality involves the use of the latent heat of vaporization, denoted in the formula by L. This value is dependent on the pressure of the steam and can be obtained from the steam tables. To avoid laborious interpolations with their attendant chances of error, however, I have compiled the accompanying table from which the values of latent heat can be read directly in B.t.u. per pound of steam. Values for pressures below 200 lb. per square inch absolute are not included, as these are given in increments of one pound pressure in the ordinary tables.

Tabulations of proportional parts (P. P.) are included for those cases where values of pressure are taken to the first decimal place. Latent heat decreases with increased pressure. Therefore, the proportional parts are negative, as is indicated by the minus sign placed before each proportional value. These proportional parts might be used as follows:

Supposing a pressure (absolute) of 363.8 is given and it is desired to find the latent heat of vaporization. Opposite the pressure 363 the latent heat is given as 790.06 B.t.u. per pound. From this must be subtracted the proportional part represented by 0.8 of a degree, so reference is made to the first division of the column headed proportional parts (P. P.) in the section between 360 and 369 pounds where the decimal 0.8 appears and opposite it the value in B.t.u. Subtract this from 790.06 and the answer is 789.84 B.t.u. per pound. If the given pressure were 368.4, the answer would have been 788.66 — 0.11 = 788.55.

These proportional parts have been worked out in groups, each group based on the average variation over a 10-lb. range of pressure.

The values are based on the steam tables of Joseph H. Keenan, published by the A. S. M. E.

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
200	842.40		
201	842.02	.1	-.04
202	841.64	.2	-.08
203	841.26	.3	-.11
204	840.88	.4	-.15
205	840.50	.5	-.19
206	840.12	.6	-.23
207	839.74	.7	-.27
208	839.36	.8	-.30
209	838.98	.9	-.34
210	838.60		
211	838.24	.1	-.04
212	837.88	.2	-.07
213	837.52	.3	-.11
214	837.16	.4	-.14
215	836.80	.5	-.18
216	836.44	.6	-.22
217	836.08	.7	-.25
218	835.72	.8	-.29
219	835.36	.9	-.32
220	835.00		
221	834.64	.1	-.04
222	834.28	.2	-.07
223	833.92	.3	-.11
224	833.56	.4	-.14
225	833.20	.5	-.18
226	832.84	.6	-.22
227	832.48	.7	-.25
228	832.12	.8	-.29
229	831.76	.9	-.32
230	831.40		
231	831.06	.1	-.04
232	830.72	.2	-.07
233	830.38	.3	-.11
234	830.04	.4	-.14
235	829.70	.5	-.18
236	829.34	.6	-.21
237	828.98	.7	-.25
238	828.62	.8	-.28
239	828.26	.9	-.32
240	827.90		
241	827.56	.1	-.03
242	827.22	.2	-.07
243	826.88	.3	-.10
244	826.54	.4	-.14
245	826.20	.5	-.17
246	825.86	.6	-.20
247	825.52	.7	-.24
248	825.18	.8	-.27
249	824.84	.9	-.31

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
250	824.50		
251	824.18	.1	-.03
252	823.86	.2	-.07
253	823.54	.3	-.10
254	823.22	.4	-.13
255	822.90	.5	-.17
256	822.56	.6	-.20
257	822.22	.7	-.23
258	821.88	.8	-.26
259	821.54	.9	-.30
260	821.20		
261	820.88	.1	-.03
262	820.56	.2	-.06
263	820.24	.3	-.10
264	819.92	.4	-.13
265	819.60	.5	-.16
266	819.28	.6	-.19
267	818.96	.7	-.22
268	818.64	.8	-.26
269	818.32	.9	-.29
270	818.00		
271	817.66	.1	-.03
272	817.32	.2	-.07
273	816.98	.3	-.10
274	816.64	.4	-.13
275	816.30	.5	-.17
276	815.98	.6	-.20
277	815.66	.7	-.23
278	815.34	.8	-.26
279	815.02	.9	-.30
280	814.70		
281	814.40	.1	-.03
282	814.10	.2	-.06
283	813.80	.3	-.09
284	813.50	.4	-.12
285	813.20	.5	-.16
286	812.88	.6	-.19
287	812.56	.7	-.22
288	812.24	.8	-.25
289	811.92	.9	-.28
290	811.60		
291	811.28	.1	-.03
292	810.96	.2	-.06
293	810.64	.3	-.09
294	810.32	.4	-.12
295	810.00	.5	-.16
296	809.70	.6	-.19
297	809.40	.7	-.22
298	809.10	.8	-.25
299	808.80	.9	-.28

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
300	808.50		
301	808.20	.1	-.03
302	807.90	.2	-.06
303	807.60	.3	-.09
304	807.30	.4	-.12
305	807.00	.5	-.15
306	806.70	.6	-.18
307	806.40	.7	-.21
308	806.10	.8	-.24
309	805.80	.9	-.27
310	805.50		
311	805.20	.1	-.03
312	804.90	.2	-.06
313	804.60	.3	-.09
314	804.30	.4	-.12
315	804.00	.5	-.15
316	803.70	.6	-.18
317	803.40	.7	-.21
318	803.10	.8	-.24
319	802.80	.9	-.27
320	802.50		
321	802.20	.1	-.03
322	801.90	.2	-.06
323	801.60	.3	-.09
324	801.30	.4	-.12
325	801.00	.5	-.15
326	800.70	.6	-.18
327	800.40	.7	-.21
328	800.10	.8	-.24
329	799.80	.9	-.27
330	799.50		
331	799.21	.1	-.03
332	798.92	.2	-.06
333	798.63	.3	-.09
334	798.34	.4	-.12
335	798.05	.5	-.15
336	797.76	.6	-.17
337	797.47	.7	-.20
338	797.18	.8	-.23
339	796.89	.9	-.26
340	796.60		
341	796.31	.1	-.03
342	796.02	.2	-.06
343	795.73	.3	-.09
344	795.44	.4	-.12
345	795.15	.5	-.15
346	794.86	.6	-.17
347	794.57	.7	-.20
348	794.28	.8	-.23
349	793.99	.9	-.26

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
350	793.70		
351	793.42	.1	-.03
352	793.14	.2	-.06
353	792.86	.3	-.08
354	792.58	.4	-.11
355	792.30	.5	-.14
356	792.02	.6	-.17
357	791.74	.7	-.20
358	791.46	.8	-.22
359	791.18	.9	-.25
360	790.90		
361	790.62	.1	-.03
362	790.34	.2	-.06
363	790.06	.3	-.08
364	789.78	.4	-.11
365	789.50	.5	-.14
366	789.22	.6	-.17
367	788.94	.7	-.20
368	788.66	.8	-.22
369	788.38	.9	-.25
370	788.10		
371	787.82	.1	-.03
372	787.54	.2	-.06
373	787.26	.3	-.08
374	786.98	.4	-.11
375	786.70	.5	-.14
376	786.42	.6	-.17
377	786.14	.7	-.20
378	785.86	.8	-.22
379	785.58	.9	-.25
380	785.30		
381	785.03	.1	-.03
382	784.76	.2	-.05
383	784.49	.3	-.08
384	784.22	.4	-.11
385	783.95	.5	-.14
386	783.68	.6	-.16
387	783.41	.7	-.19
388	783.14	.8	-.22
389	782.87	.9	-.24
390	782.60		
391	782.32	.1	-.03
392	782.04	.2	-.06
393	781.76	.3	-.08
394	781.48	.4	-.11
395	781.20	.5	-.14
396	780.92	.6	-.17
397	780.64	.7	-.20
398	780.36	.8	-.22
399	780.08	.9	-.25

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
400	779.80		
401	779.54	.1	-.03
402	779.28	.2	-.05
403	779.02	.3	-.08
404	778.76	.4	-.10
405	778.50	.5	-.13
406	778.24	.6	-.16
407	777.98	.7	-.18
408	777.72	.8	-.21
409	777.46	.9	-.23
410	777.20		
411	776.93	.1	-.03
412	776.66	.2	-.05
413	776.39	.3	-.08
414	776.12	.4	-.11
415	775.85	.5	-.14
416	775.58	.6	-.16
417	775.31	.7	-.19
418	775.04	.8	-.22
419	774.77	.9	-.24
420	774.50		
421	774.24	.1	-.03
422	773.98	.2	-.05
423	773.72	.3	-.08
424	773.46	.4	-.10
425	773.20	.5	-.13
426	772.94	.6	-.16
427	772.68	.7	-.18
428	772.42	.8	-.21
429	772.16	.9	-.23
430	771.90		
431	771.64	.1	-.03
432	771.38	.2	-.05
433	771.12	.3	-.08
434	770.86	.4	-.10
435	770.60	.5	-.13
436	770.34	.6	-.16
437	770.08	.7	-.18
438	769.82	.8	-.21
439	769.56	.9	-.23
440	769.30		
441	769.04	.1	-.03
442	768.78	.2	-.05
443	768.52	.3	-.08
444	768.26	.4	-.10
445	768.00	.5	-.13
446	767.74	.6	-.16
447	767.48	.7	-.18
448	767.22	.8	-.21
449	766.96	.9	-.23
450	766.70		
451	766.44	.1	-.03
452	766.18	.2	-.05
453	765.92	.3	-.08
454	765.66	.4	-.10
455	765.40	.5	-.13
456	765.14	.6	-.16
457	764.88	.7	-.18
458	764.62	.8	-.21
459	764.36	.9	-.23
460	764.10		
461	763.85	.1	-.03
462	763.60	.2	-.05
463	763.35	.3	-.08
464	763.10	.4	-.10
465	762.85	.5	-.13
466	762.60	.6	-.15
467	762.35	.7	-.18
468	762.10	.8	-.20
469	761.85	.9	-.23
470	761.60		
471	761.34	.1	-.03
472	761.08	.2	-.05
473	760.82	.3	-.08
474	760.56	.4	-.10
475	760.30	.5	-.13
476	760.04	.6	-.16
477	759.78	.7	-.18
478	759.52	.8	-.21
479	759.26	.9	-.23
480	759.00		
481	758.75	.1	-.03
482	758.50	.2	-.05
483	758.25	.3	-.08
484	758.00	.4	-.10
485	757.75	.5	-.13
486	757.50	.6	-.15
487	757.25	.7	-.18
488	757.00	.8	-.20
489	756.75	.9	-.23
490	756.50		
491	756.25	.1	-.03
492	756.00	.2	-.05
493	755.75	.3	-.08
494	755.50	.4	-.10
495	755.25	.5	-.13
496	755.00	.6	-.15
497	754.75	.7	-.18
498	754.50	.8	-.20
499	754.25	.9	-.23

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
500	754.00		
501	753.75	.1	-.03
502	753.50	.2	-.05
503	753.25	.3	-.08
504	753.00	.4	-.10
505	752.75	.5	-.13
506	752.50	.6	-.15
507	752.25	.7	-.18
508	752.00	.8	-.20
509	751.75	.9	-.23
510	751.50		
511	751.25	.1	-.03
512	751.00	.2	-.05
513	750.75	.3	-.08
514	750.50	.4	-.10
515	750.25	.5	-.13
516	750.00	.6	-.15
517	749.75	.7	-.18
518	749.50	.8	-.20
519	749.25	.9	-.23
520	749.00		
521	748.76	.1	-.02
522	748.51	.2	-.05
523	748.27	.3	-.07
524	748.02	.4	-.10
525	747.78	.5	-.12
526	747.53	.6	-.15
527	747.29	.7	-.17
528	747.04	.8	-.20
529	746.80	.9	-.22
530	746.55		
531	746.31	.1	-.02
532	746.06	.2	-.05
533	745.82	.3	-.07
534	745.57	.4	-.10
535	745.33	.5	-.12
536	745.08	.6	-.15
537	744.84	.7	-.17
538	744.59	.8	-.20
539	744.35	.9	-.22
540	744.10		
541	743.86	.1	-.02
542	743.62	.2	-.05
543	743.38	.3	-.07
544	743.14	.4	-.10
545	742.90	.5	-.12
546	742.66	.6	-.14
547	742.42	.7	-.17
548	742.18	.8	-.19
549	741.94	.9	-.22
550	741.70		
551	741.46	.1	-.02
552	741.22	.2	-.05
553	740.98	.3	-.07
554	740.74	.4	-.10
555	740.50	.5	-.12
556	740.26	.6	-.14
557	740.02	.7	-.17
558	739.78	.8	-.19
559	739.54	.9	-.22
560	739.30		
561	739.06	.1	-.02
562	738.82	.2	-.05
563	738.58	.3	-.07
564	738.34	.4	-.10
565	738.10	.5	-.12
566	737.86	.6	-.14
567	737.62	.7	-.17
568	737.38	.8	-.19
569	737.14	.9	-.22
570	736.90		
571	736.66	.1	-.02
572	736.42	.2	-.05
573	736.18	.3	-.07
574	735.94	.4	-.10
575	735.70	.5	-.12
576	735.46	.6	-.14
577	735.22	.7	-.17
578	734.98	.8	-.19
579	734.74	.9	-.22
580	734.50		
581	734.27	.1	-.02
582	734.03	.2	-.05
583	733.80	.3	-.07
584	733.56	.4	-.09
585	733.33	.5	-.12
586	733.09	.6	-.14
587	732.86	.7	-.16
588	732.62	.8	-.19
589	732.39	.9	-.21
590	732.15		
591	731.92	.1	-.02
592	731.68	.2	-.05
593	731.45	.3	-.07
594	731.21	.4	-.09
595	730.98	.5	-.12
596	730.74	.6	-.14
597	730.51	.7	-.16
598	730.27	.8	-.19
599	730.04	.9	-.21

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
600	729.80		
601	729.57	.1	-.02
602	729.33	.2	-.05
603	729.10	.3	-.07
604	728.86	.4	-.09
605	728.63	.5	-.12
606	728.39	.6	-.14
607	728.16	.7	-.16
608	727.92	.8	-.19
609	727.69	.9	-.21
610	727.45		
611	727.22	.1	-.02
612	726.98	.2	-.05
613	726.75	.3	-.07
614	726.51	.4	-.09
615	726.28	.5	-.12
616	726.04	.6	-.14
617	725.81	.7	-.16
618	725.57	.8	-.19
619	725.34	.9	-.21
620	725.10		
621	724.87	.1	-.02
622	724.64	.2	-.05
623	724.41	.3	-.07
624	724.18	.4	-.09
625	723.95	.5	-.12
626	723.72	.6	-.14
627	723.49	.7	-.16
628	723.26	.8	-.18
629	723.03	.9	-.21
630	722.80		
631	722.57	.1	-.02
632	722.34	.2	-.05
633	722.11	.3	-.07
634	721.88	.4	-.09
635	721.65	.5	-.12
636	721.42	.6	-.14
637	721.19	.7	-.16
638	720.96	.8	-.18
639	720.73	.9	-.21
640	720.50		
641	720.27	.1	-.02
642	720.04	.2	-.05
643	719.81	.3	-.07
644	719.58	.4	-.09
645	719.35	.5	-.12
646	719.12	.6	-.14
647	718.89	.7	-.16
648	718.66	.8	-.18
649	718.43	.9	-.21
650	718.20		
651	717.97	.1	-.02
652	717.74	.2	-.05
653	717.51	.3	-.07
654	717.28	.4	-.09
655	717.05	.5	-.12
656	716.82	.6	-.14
657	716.59	.7	-.16
658	716.36	.8	-.18
659	716.13	.9	-.21
660	715.90		
661	715.67	.1	-.02
662	715.44	.2	-.05
663	715.21	.3	-.07
664	714.98	.4	-.09
665	714.75	.5	-.12
666	714.52	.6	-.14
667	714.29	.7	-.16
668	714.06	.8	-.18
669	713.83	.9	-.21
670	713.60		
671	713.37	.1	-.02
672	713.14	.2	-.05
673	712.91	.3	-.07
674	712.68	.4	-.09
675	712.45	.5	-.12
676	712.22	.6	-.14
677	711.99	.7	-.16
678	711.76	.8	-.18
679	711.53	.9	-.21
680	711.30		
681	711.08	.1	-.02
682	710.85	.2	-.05
683	710.63	.3	-.07
684	710.40	.4	-.09
685	710.18	.5	-.11
686	709.95	.6	-.14
687	709.73	.7	-.16
688	709.50	.8	-.18
689	709.28	.9	-.20
690	709.05		
691	708.83	.1	-.02
692	708.60	.2	-.05
693	708.38	.3	-.07
694	708.15	.4	-.09
695	707.93	.5	-.11
696	707.70	.6	-.14
697	707.48	.7	-.16
698	707.25	.8	-.18
699	707.03	.9	-.20

LB. PER SQ.IN.	B.T.U. PER LB.	P.P.	
700	706.80		
701	706.58	.1	-.02
702	706.36	.2	-.04
703	706.14	.3	-.07
704	705.92	.4	-.09
705	705.70	.5	-.11
706	705.48	.6	-.13
707	705.26	.7	-.15
708	705.04	.8	-.18
709	704.82	.9	-.20
710	704.60		
711	704.38	.1	-.02
712	704.16	.2	-.04
713	703.94	.3	-.07
714	703.72	.4	-.09
715	703.50	.5	-.11
716	703.28	.6	-.13
717	703.06	.7	-.15
718	702.84	.8	-.18
719	702.62	.9	-.20
720	702.40		
721	702.18	.1	-.02
722	701.95	.2	-.05
723	701.73	.3	-.07
724	701.50	.4	-.09
725	701.28	.5	-.11
726	701.05	.6	-.14
727	700.83	.7	-.16
728	700.60	.8	-.18
729	700.38	.9	-.20
730	700.15		
731	699.93	.1	-.02
732	699.70	.2	-.05
733	699.48	.3	-.07
734	699.25	.4	-.09
735	699.03	.5	-.11
736	698.80	.6	-.14
737	698.58	.7	-.16
738	698.35	.8	-.18
739	698.13	.9	-.20
740	697.90		
741	697.68	.1	-.02
742	697.46	.2	-.04
743	697.24	.3	-.07
744	697.02	.4	-.09
745	696.80	.5	-.11
746	696.58	.6	-.13
747	696.36	.7	-.15
748	696.14	.8	-.18
749	695.92	.9	-.20
750	695.70		
751	695.48	.1	-.02
752	695.26	.2	-.04
753	695.04	.3	-.07
754	694.82	.4	-.09
755	694.60	.5	-.11
756	694.38	.6	-.13
757	694.16	.7	-.15
758	693.94	.8	-.18
759	693.72	.9	-.20
760	693.50		
761	693.29	.1	-.02
762	693.07	.2	-.04
763	692.86	.3	-.06
764	692.64	.4	-.09
765	692.43	.5	-.11
766	692.21	.6	-.13
767	692.00	.7	-.15
768	691.78	.8	-.17
769	691.57	.9	-.19
770	691.35		
771	691.14	.1	-.02
772	690.92	.2	-.04
773	690.71	.3	-.06
774	690.49	.4	-.09
775	690.28	.5	-.11
776	690.06	.6	-.13
777	689.85	.7	-.15
778	689.63	.8	-.17
779	689.42	.9	-.19
780	689.20		
781	688.99	.1	-.02
782	688.77	.2	-.04
783	688.56	.3	-.06
784	688.34	.4	-.09
785	688.13	.5	-.11
786	687.91	.6	-.13
787	687.70	.7	-.15
788	687.48	.8	-.17
789	687.27	.9	-.19
790	687.05		
791	686.84	.1	-.02
792	686.62	.2	-.04
793	686.41	.3	-.06
794	686.19	.4	-.09
795	685.98	.5	-.11
796	685.76	.6	-.13
797	685.55	.7	-.15
798	685.33	.8	-.17
799	685.12	.9	-.19

Utility Leaders Defend Electrical

Two Thousand Utility Executives and Engineers Discuss Problems of the Electrical Industry at Edison Electric Institute Convention at St. Louis. Defend Record of the Industry Against Attack of Government Ownership Protagonists. Face Future with Confidence and Enthusiasm. Charles W. Kellogg Elected President.

THE FOURTH ANNUAL CONVENTION of the Edison Electric Institute held at St. Louis during the week of June first was more like the conventions of its historic predecessor, The National Electric Light Association, than any held since the new organization was formed three years ago. Both in spirit and in point of attendance the meeting brought back memories of those great gala gatherings of the more prosperous days at Atlantic City.

True, there was still concern and apprehension regarding the policies and tactics of the government and there was plenty of resentment and well-founded criticism of administration policies, but this criticism was delivered, not in the attitude of resignation that prevailed several years ago, but in a spirit of aggressive determination that the virtues of private ownership of utilities would prevail in the end. As one commentator expressed it, "there is something about them this year that suggests the upward emergence from a protracted seige." There was more enthusiasm, more good-natured humor, more hope for the successful future of the industry than has been displayed at any of the Institute's conventions since the first one three years ago.

And for good reason. With the power load higher than it has ever been before and still increasing, with better general business conditions throughout the nation, with housing operations mounting steadily, presaging still greater loads, with splendid opportunities for new operating economies at hand and, last but by no means least, with some seven Supreme Court decisions unfavorable to the government to the year's credit, the outlook for the utilities is very hopeful, despite high taxes, and the T.V.A.

The three disturbing elements in the government's activities that continue to cause apprehension are: first, holding company legislation; second, T.V.A. operation, and, third, loans or government grants to municipalities for power purposes, and the Institute as an organization continues in its vigorous denunciation of, and opposition to, all of these measures. Regulation of Utilities also presents troublesome problems though here the opposition concerns only the matter of degree. Utility leaders generally admit, whether by force of reason or circumstance, that a certain measure of regulation is necessary but they object to the degree to which such regulation is being carried. In his presidential address as retiring chief executive of the Institute, Thomas McCarter protested vigorously against all of these measures and urged the continued opposition of them by the Institute and the industry as a whole.

The efforts of the Institute and the industry, however, are being directed not only in the defense of the utilities' practices and policies, but a sustained and vigorous effort is being made to regain public confidence and to do a better job in the public interest. And, as a matter of fact, the utilities are doing a good job. Whatever opinion one may have on the general question of power in the national picture, one must admit that the utility business today, especially as concerns the operating companies, is as fair and free from unsound practices as any business that can be mentioned.

The utilities are at a disadvantage in gaining public confidence due to the intangible nature of the product (if electrical energy can be called a product) they sell. Electricity is a mysterious thing which the public can neither understand nor trust. They do not understand its language and since they do not understand are easily led to believe anything that may be said about the business.

How Can They Know?

The keynote of the St. Louis meeting, if so diversified a program can be said to have had a keynote, was that it is up to the utilities to tell their story to the public. Several of the most important papers stressed that fact at great length and with unusual forcefulness. Of particular importance in this respect was the paper "How Can They Know?" by Dr. Adam S. Bennion, Assistant to the President of the Utah Power & Light Co. That title, said Dr. Bennion, grew out of a discussion among a group of men sometime ago in a utility company office as a result of the query: "Why do so many people feel as they do toward the utilities?"

The usual observations were included in:

"Too much money going to New York."

"Too much Wall Street control."

"Demand charge too high."

Industry's Record *at* St. Louis Meeting

"The people don't understand our business—they don't even know our language."

It was this last remark that prompted the forceful "How Can They Know?" How can people know what to believe about the issues in the utility wrangle of the last four or five years? Dr. Bennion pointed many men who, normally, do good straight thinking are disturbed and confused in their mental processes and are unable properly to evaluate the information or misinformation that comes to them on the utility question. As a consequence there has developed an anomalous situation; one of the finest industries in America is, as Dr. Bennion put it, "in the dog house."

Dr. Bennion's plea was for a concentrated effort on the part of the utility companies to promote a better understanding of the utility business in the mind of the public. Specifically, his paper described a plan which had met with marked success in his own company. It involved the organization of employees into groups, with meetings and discussions which were directed toward better public relations, towards methods of giving the customers accurate dependable information about the utility industry and its workings. In his own company, he said, if each of the 2000 employees has dealings with 10 people per month, that is 20,000 a month, 240,000 a year. At the same rate, the 250,000 employees in the nation's utilities could contact 2,500,000 a month—30,000,000 a year. The answer to "How Can They Know?" is—*Enthusiastic, well-informed employees.*

Louis Egan on St. Louis

Throughout the entire week, from Louis Egan's novel address of welcome on Monday afternoon to the installation of C. W. Kellogg as the new president immediately before adjournment on Thursday, the meeting was an interesting, well ordered affair; it was well attended and the papers were well selected and well presented.

Precedent was broken in dispensing with an official welcome by a paid politician or any other city dignitary but Louis Egan's graceful welcoming remarks more than compensated for any absence of political representation. Indeed, his address was of quite a different character from the usual address of welcome and his friend, Floyd Carlisle, later amused himself and the audience by poking fun at it. "It was, said Mr. Carlisle, "not a normal address at all; it was more a rendition in blank verse. * * * The only people referred to in the speech were a few saints."

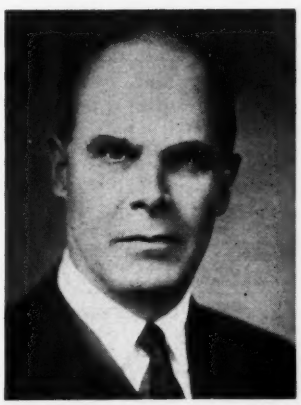
Notwithstanding Mr. Carlisle's amusing comments, Mr. Egan's address was well put and it may well stand as an example of what a welcoming address should be like. Indulging in neither figures nor useless facts, he painted a charming historic background for St. Louis and suggested a few of its virtues. "In St. Louis," he concluded, "the agressiveness of the virile north is mingled with and softened by the gracious charm and hospitality of the south." Only words, perhaps, but rather nicely expressed.

Air Conditioned Sessions

Mr. Egan's address was rendered more impressive by virtue of the surroundings in which it was delivered. For this convention was held in St. Louis' new $7,000,000 municipal auditorium, than which there are few more impressive. Indeed, the meeting facilities at this convention were of the finest. With the temperature outside at 90 degrees, it was quite delightful to sit in the effectively air-conditioned auditorium. St. Louis may well be proud of this structure.

From Mr. Egan's verbal niceties to the hard, cold facts of Norman Gibson's paper on The Cost of Electric Service was considerable of a transition but in the air-conditioned auditorium it was accomplished with ease. This was the first paper to be presented.

Cost of service, according to Mr. Gibson, who is vice president of the Buffalo, Niagara and Eastern Power Corporation, is a most disappointing will-o-the-wisp, when an attempt is made to fix that cost for the various types and classes of service furnished. Cost of service to any one customer or to any class of customers has about as many different values as there are theorists trying to find them. An analysis of cost at best can be used only to guide the judgment of the management in fixing prices which will support the business as a whole. Mr. Gibbons advanced little hope for substantial rate reductions in electric-



CHARLES W. KELLOGG, the new president of the E.E.I. has devoted his entire career to the public utility industry. For 33 years, since his graduation from M.I.T. he has been with the Stone and Webster organization, acquiring an unusual breadth of experience in the three main branches of the utility business—operating, engineering and finance. Since 1934 he has been chairman of the board of Engineers Public Service Co. Mr. Kellogg was born in Philadelphia February 27, 1880. After graduation he began work with Stone and Webster, becoming manager of the Edison Co. at Brockton, Mass., in 1905. Later he managed properties at El Paso and Keokuk, returning East in 1919. During the following six years he was engaged in expert work on reports, appraisals, etc., including work for the Interborough Rapid Transit Co. and the Conowingo project on the Susquehanna River. Since going to New York in 1925 he has won recognition throughout the industry for his exceptional qualifications in utility leadership in matters of both administration and policy.

ity during the next few years. No revolutionary discoveries seem to be in sight which will materially reduce distribution costs. On the contrary, the exacting demands for continuity of service and constant voltage and increasing demands on the part of municipalities that distributing lines be put underground, are more likely to increase distribution costs. Only in new and more diversified use of existing investment lies the chief hope for lower costs and still lower rates.

Rates Not Too High, says W. G. Vincent

W. G. Vincent, vice president of the Pacific Gas and Electric Company, defended present electrical rates. In discussing an analysis of the average domestic electric bill for the last 30 yr. in 51 representative cities, he said rate reductions since 1926 to date had brought a total saving to consumers of $2,021,839,000. He pointed out that the average rate per kw. hr. 50 yr. ago was 25 cents and except for one year at the close of the war, there had been a continuous annual decrease until 1935 when the average reached 5 cents.

I may be over-optimistic, but I think I sense that the peak of this fight has passed. There never was any real basis for it except a few isolated cases of mishandling of securities by certain manipulators and promoters, the wrong-doing of whom is in no sense chargeable to the industry as a whole. ****The public is beginning to see that there is nothing in the issue, and evidence abounds that the great mass of the people in this country are thoroughly satisfied with the service rendered by the industry and the extremely low prices charged for such service—which have now reached in the case of residential customers an average price to them of less than 10c per day.
—Thomas N. McCarter.

In emphasizing the value of electrical service to the public, Mr. Vincent pointed out that despite the shrinkage in incomes in the last 5 yr. making it necessary for many to drop something out of their scale of living, the consumption of electricity had actually increased steadily. This, said Mr. Vincent, is conclusive proof that the value of electrical service is extremely high, in fact higher than most other things for which they spend their incomes.

Have We Become Too Expert in Bookkeeping?

The affirmative answer to this question was an opinion cited by Luther R. Nash, vice president of Stone and Webster, who led the presentation of a group of papers on the general subject of Utility Accounting. The opinion, said Mr. Nash, was one expressed recently by a well known industrial engineer but in the light of recent developments, his (Mr. Nash's) associates on the Institute's Accounting Committee were heartily in accord with the statement if it implied that they have become so involved in technicalities as to lose sight of their real objective.

Although the subject of accounting to the non-accountant is a dry subject, this group of papers proved of unusual interest. The general idea expressed was that the maze of bookkeeping details is rapidly becoming so thick that it obscures all vision of real objectives and that accounting systems are being made the machinery for the confiscation of utility property.

There were five papers in this group. The first one, by Mr. Nash, dealt with the fundamentals of Utility Accounting. Next was an interesting one entitled, "Aboriginal Cost" by H. L. Gruehn of the Consolidated Gas, Electric Light and Power Co. of Baltimore. Third was a paper, "Continuing Inventories" by H. B. Gear of the Commonwealth Edison Co., Chicago. Fourth, one on "Cost and Economic Value of Accounting Elaborations" by C. E. Kohlhepp of the Wisconsin Public Service Corp., and finally, a paper on "Merchandising Accounting" by W. H. Swinney of the West Penn Power Co.

The title of Mr. Gruehn's paper, "Aboriginal Cost" of course was facetious and the paper was devoted to an analysis and criticism of the term "original" cost, used officially by government organizations in arriving at the value of utility properties. "This amazing doctrine," said Mr. Gruehn, "proposes that we shall replace our present balance sheet data with figures which are neither 'cost' nor 'value'. It assumes the knowledge of hindsight in expecting that the original owner knew at the time he installed an item of property just how long it would last and the principle quite destroys, after several years of its operation, the ability of a utility to ascertain the costs of its property to the present owners."

Supplementing the remarks of Messrs. Nash and Gruehn, C. E. Kohlhepp made a plea for simpler accounting systems. "If there is any one thing that this nation needs most," he declared, "it is a return to the old fashioned concept that cost should not exceed economic or useful value whether it be of accounting, shoes, steam plants, CWA, PWA, AAA or TVA." "This," he said, "did not imply that all accounting elaborations are uneconomic. Much of what is done today is fundamentally sound and in addition, considerable detail is made necessary, by regulatory or taxation requirements, rather than the needs of management or investor. A suitable accounting system, matched to the size and needs of a business, throws to the surface significant facts. The cost of detail is justified if the management is materially aided in understanding the present or charting its future course. The converse of this is that unusued or unusable accounting elaboration is absurd."

Mr. Gear's and Mr. Swinney's papers were of a more specific nature. Mr. Gear described the details of a reproduction cost estimate completed recently for the property of the Commonwealth Edison Co. in about four months. The property has a value of $300,000,000. The results obtained in this work were so successful that it became the basis for the system of continuous inventory which Mr. Gear described.

Mr. Swinney emphasized the function of accounting as a measurement of sales results as well as a record of income and outgo.

The President's Address

The principal feature of the Tuesday morning session was the address of Thomas McCarter, the retiring president of the Institute.

Mr. McCarter expressed the opinion that the peak of the Governmental attacks on the electric light and power industry had passed. I may be over-optimistic," he declared, "but I think I sense that the peak of this fight has passed. There never was any real basis for it except a few isolated cases of the mishandling of securities by certain manipulators and promotors, the wrongdoing of whom is in no sense chargeable to the industry as a whole. The issue, so far as it was an issue, was one that was politically manufactured. The public are beginning to see that there is nothing in it, and evidence abounds that the great mass of the people in this country are thoroughly satisfied with the service rendered by the industry and the extremely low prices charged for such service, which have now reached in the case of residential customers an average price to them of less than 10 cents per day."

At the same time he urged continued vigorous opposition by the Institute and the industry to governmental interference and attack. "What the attitude of the Trustees of the Institute in the future in regard to these matters will be, I do not pretend to say," said Mr. McCarter. "But having put our hand to the plow, I do not think we should stop until these questions are all finally and fundamentally determined. . . . I have no quarrel with proper regulation of public utilities, but I am unalterably opposed to it when it seeks to include management, for this is the worst kind of government ownership because it lacks financial responsiblity."

Electrify Your Kitchen

It seemed rather an abrupt change to proceed directly from the president's address to a paper on kitchens, however, kitchens form an important part in our lives and because of this the electrical industry will do well to give it more attention. These at least were the opinions voiced by G. E. Whitwell in his paper "Modernize—Electrify Your Kitchen." Pointing to the success obtained by the Institute in launching the electric refrigerator campaign and the "Better Light Better Sight" movement in the sale of refrigerators and lighting equipment, he urged a similar campaign in the sale of kitchen appliances. "I offer you," he said, "the Kitchen Modernizing Program as a method of replacing the old with the new; of putting to work the tremendous advances in technology of electric kitchen appliances; of increasing employment by creating more jobs through making existing electrical goods and services constantly better."

Mr. Whitwell's address was followed by one by J. F. Owens on the contributions of the electrical industry to the well-being of a state. The state, of course, was his own state, Oklahoma, and the particular company his own company, The Oklahoma Gas and Electric Co. of which he is president.

Discussing the extent of electrification in the nation, Mr. Owens indicated that:

(a) Every town or city in the U. S. over 1000 population has electric service. Eighty-two per cent of such towns are served exclusively by private companies.

(b) 99.7 per cent of the total population of the U. S. living in incorporated communities has access to electric service. Eighty-eight per cent are served by private utilities.

(c) Ninety per cent of the incorporated communities in the U. S. under 1000 population have electric service.

The final feature of the Tuesday morning session at which these addresses by the President, Messrs. Whitwell and Owens were presented, was an address by Harper Sibley, President of the Chamber of Commerce of the United States, who spoke in defense of the utilities against the enlarging scope of government control.

Rural Electrification

The Third General Session on Wednesday morning was largely devoted to a consideration of electricity as it relates to the farmer. The last four papers presented at this session dealt exclusively with this topic.

There were several other papers, however. The first one, following a brief discussion of, and an invitation to, the Third World Power Conference to be held in Washington in September, by Floyd Carlisle, was a rather technical paper by S. M. Dean of The Detroit Edison Co., entitled "Firm Ratings as a Guide to System Loadng and Design." "Because of the uncertainty as to the future and consequent reluctance to increase investment in property more than actually necessary, the question of how far an electrical system may be loaded without undue hazard has become one of increasing importance," said Mr. Dean. "It has been said that the operation of an electrical system consists in large part of the intelligent taking of chances and that certainly applies to the loading of it." However, Mr. Dean pointed out that intelligent analysis of system elements will provide a method of "Firm Rating" which he defined as the amount to which the load may be increased before additional equipment must be provided. His paper which was supplemented by charts and tables showed how this method of Firm Rating may be applied to the various parts of an electrical system.

"Present Aspects of Utility Financing" was the subject of a paper by C. W. Kellogg. He defended holding company policies and showed how the holding companies had influenced the raising of the immense sums of money invested in the electric light and power business. "The financial stability of the electric utilities during the depression," he said, "has been demonstrated by the fact that the total cost to the investor of electric utility securities in both operating and holding companies in receivership during he past five years has been but 5⅔ per cent of the fixed capital in the industry, and the loss to the investor about 4⅔ per cent of such capital. This compares with 21.7 per cent in the case of steam railroads, with 37.5 per cent in the case of foreign securities and with 61.7 per cent in real estate.

Reduce Farm Wiring Costs

Dr. E. A. White led the discussion of the farm problem with his paper "Why the farmer is increasingly interested in electricity." This, of necessity, was quite general but it pointed out that only through complete cooperation and mutual understanding between the utility company and the farmer can further electrification of agriculture be made successful.

This paper was followed by two which discussed new developments in farm wiring and in farm lines, the first by E. A. Brand of the Niagara Hudson Power Corp. and the second by A. E. Silver of Ebasco Services, Inc. Both of these papers stressed the necessity for simpler, cheaper methods and devices. In comparing the cost of various wiring methods Mr. Brand showed that rigid conduit wiring costs almost twice as much as knob and tube wiring and indicated that for many farm purposes, knob and tube wiring was entirely adequate. Protected neutral cable is another important development in wiring technology, he said, and is one that deserves the hearty support of all utility companies. High investment costs represent a serious problem to the majority of potential farm customers and every effort should be made to reduce them.

The final paper at this session was one by W. W. Freeman of the Columbia Gas and Electric Corp. on the Relations of the Industry and the Rural Electrification Administration. In this paper, Mr. Freeman pointed out that the operation of the R.E.A. would probably serve in many ways to confirm the soundness of policies already pursued by the industry in regard to rural electrification.

The Campaign to Destroy

The papers at the fourth general session were quite varied, ranging all the way from discussions of the effect of sales programs to methods of house ventilation but the paper that commanded the greatest amount of attention was one by Frank T. Post, president of the Washington Water Power Co. of Spokane, entitled "The Campaign to Destroy." Part of the effectiveness of this address was due to the manner in which it was delivered, for Mr. Post has a keen sense of humor and an excellent stage manner, but, of course, the subject also was one dear to the hearts of utility men. His address was a scathing denunciation and criticism of the "New Deal" and its policies relating to the power industry. "In this brief summary," Mr. Post said in closing, "I have undertaken to demonstrate that for the past three years there has been evolved and developed by the inner circle of the New Deal a plan or plans to hamstring, strangle and destroy all the electric utilities, big and little, in this country, with public ownership and political operation as the ultimate end in view." He was, however, not pessimistic. "We need not be disheartened," he continued. "We know that demagogues thrive best in times of distress. . . . We know that the American people, now as always heretofore, are opposed to government in business and that they are not likely to accept paternalism, socialism, fascism, communism, Hitlerism or any other ism except Americanism."

Mr. Post's address was followed by three papers dealing with the general subject of Air Conditioning. Air Conditioning is a subject of considerable interest to the operating companies as they see in it splendid opportunities for load building. At this session, C. E. Michel of the Union Electric Light and Power Co. of St. Louis presented a review of the utility's position in the air conditioning field. This was followed by two papers, one by R. H. Tillman on Room Cooling with Portable Units and the other by W. G. Moore on House Ventilation Through the Attic. Of importance in the portable unit field, said Mr. Tillman, was the recent development of a self-contained unit conditioner using air for condenser cooling. The use of air instead of water for condenser cooling greatly simplifies the use of these devices, such almost any room has a window which can be adapted to provide a source of outside air.

The Final Session

The fifth and final session on Thursday morning was short but interesting since it was at this session that Dr. Adam Bennion presented his paper "How Can They Know" which has already been mentioned. C. E. Greenwood of the Institute also presented a paper which reviewed three decades of utility sales development.

Convention activities were concluded with the announcement and presentation of prize awards. The Charles A. Coffin Medal was awarded to the Idaho Power Co.

Finally came the announcement of new officers and the installation of the new president, C. W. Kellogg, chairman of the board of the Engineers Public Service Co.

Versatile Joseph Nason

In connection with the passage of the company founded by Joseph Nason as the Nason Mfg. Co. into the ownership of W. P. Thomas, president and G. L. Davis, sales manager of the Diamond Specialty Power Co., it is of interest to note that Mr. Nason, a pioneer in the devising and application of heating equipment, was the adapter of the globe valve for straight pipe lines, as it had previously been used only in the angle form; he also devised the taper thread for pipe joints, giving it the form which has continued in use to the present time, a period of nearly 100 yr. Malleable-iron fittings in place of cast-iron ones were introduced by him to reduce cost and weight. To the ideas of Mr. Nason, worked out experimentally by Mr. Briggs, his partner, was due the introduction of the steam radiator with a divided tube to replace the costly and cumbersome box coils of pipe that had been used. Many other improvements were the children of his brain, including the balanced regulating valve for controlling pressure. His plans were the ones accepted in 1855 for warming and ventilating the United States Capitol building, the ventilation involving the working out of centrifugal fans 12 and 16 ft. diam. with blades recurred on a logarithmic spiral, a form that soon became standard for such fans. Mr. Nason was characterized by Mr. Briggs as the best informed and most experienced person on heating and ventilation in the United States at that time.

Readers' Conference

The Plant Today

WITH GREAT INTEREST I have read the article "The Plant Today," appearing in the January, 1936, issue. I believe that one statement in regard to mercury vapor-steam cycles could be easily misinterpreted. The statement to which I have reference is in the third paragraph on page 13, namely: "If, however, the steam cycle can be raised to the same temperature limits, the advantage of the mercury vapor cycle disappears as its complexity demands a considerable efficiency advantage to be practical."

In general the efficiency of a power cycle is determined by the temperature range through which it operates. The greater the temperature range, the higher the efficiency. It makes considerable difference, however, whether the high initial temperature is obtained by increasing the pressure, or by superheating the vapor. The energy required to superheat vapor to a certain temperature is only a fraction of that necessary to obtain the same temperature by increasing the pressure and maintaining the vapor in a saturated condition.

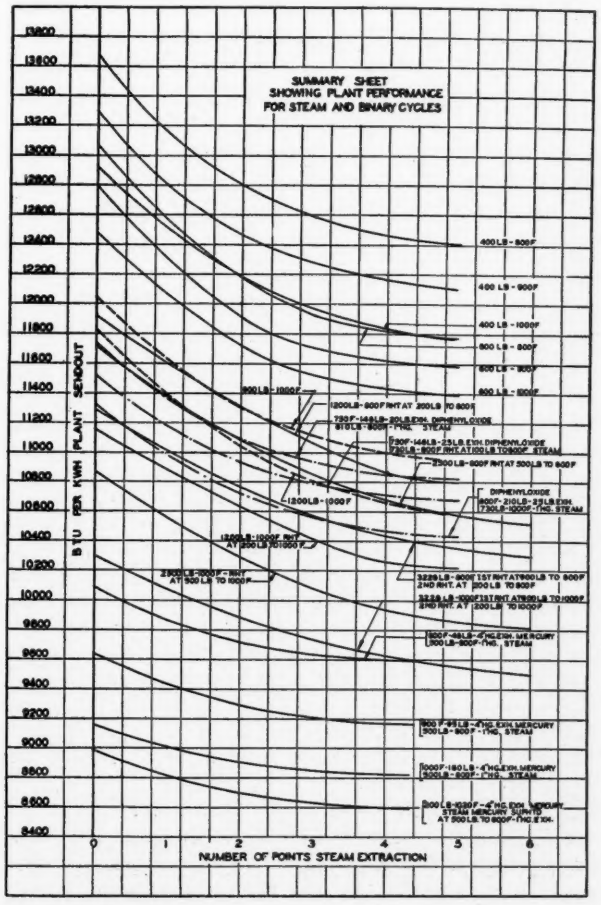

SUMMARY SHEET
SHOWING PLANT PERFORMANCE
FOR STEAM AND BINARY CYCLES
B T U PER KWH PLANT SENDOUT
NUMBER OF POINTS STEAM EXTRACTION
400 LB - 800F
400 LB - 900F
400 LB - 1000F
800 LB - 900F
800 LB - 1000F
1200 LB - 1000F

Fig. 1. Reproduction of Fig. 12 from Dr. Gaffert's paper

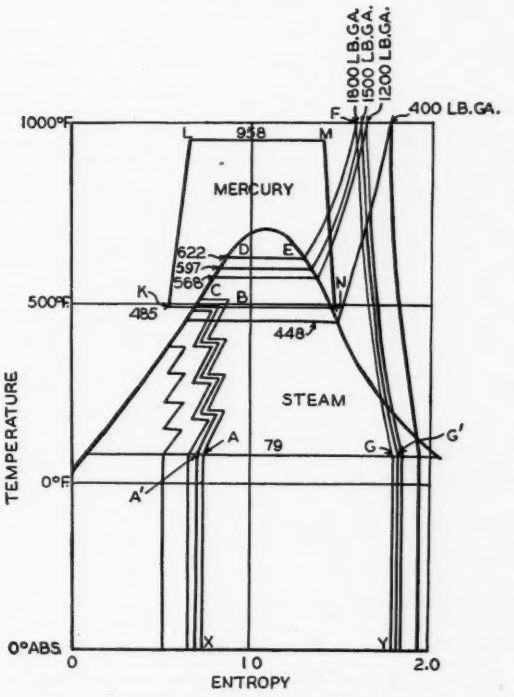


Fig. 2. Temperature-entropy diagrams for various steam and mercury cycles

EDITOR'S NOTE

By definition the change in entropy is the change in heat content in B.t.u. divided by the absolute temperature so that on a temperature entropy diagram (Fig. 2 above) areas represent heat in B.t.u. Thus for the 1800 lb. curve the area X A B C D E F G Y represents heat input and the area X A G Y the condenser loss of heat rejected. The useful area or work is then A B C D E F G A.

There is little difference in these areas for the 1800 and 1500 lb. cycle but in the latter case the condenser loss, under the lines G^1 A^1, is considerably greater and consequently the efficiency is lower. It is obvious that the efficiency of the 400 lb. steam cycle is lower than the other three but with the mercury cycle added the net area is increased by K L M N without increasing the condenser loss so that the efficiency of the combined cycle is much higher. Theoretically, there is no reason why the steam cycle could not be superimposed on another fluid such as SO_2 and further increase the efficiency. This was experimented with extensively in Germany during the early part of this century but never reached commercial importance.

The temperature entropy diagram emphasizes the point mentioned by Mr. Thompson, i.e., that the temperature of a superheated vapor cycle is by itself no measure of the cycle efficiency. The extraction cycle closely approaches the Carnot cycle and for saturated vapor the temperature limits give a close and simple approximation of the cycle efficiency. As the superheat is increased, this approximation becomes less valid due to the peak in the supreheated region at the right hand side of the diagram. These relationships are explained more fully in an article on page 41 of the January 1, 1932, issue, "Steam cycle is the foundation of the power plant."

Thus the gain in economy by superheating is small compared to the gain in economy by raising the temperature through an increase of pressure. Now with steam, even though we go to the critical pressure of 3226 lb. per sq. in., the saturated temperature is only 706 deg. F., while mercury at the same temperature has a gauge pressure of only 5 lb. per sq. in. The higher temperature is obtained by increasing the mercury pressure and thus the mercury-steam cycle approaches more nearly the ideal cycle efficiency. Even at a temperature of 1000 deg. F. the mercury gauge pressure is only 165 lb. per sq. in.

A paper by Dr. G. A. Gaffert, appearing in Transactions of A.S.M.E., Vol. 56, No. 10, F.S.P. 56-11 (see p. 597 December 1934 issue of Power Plant Engineering for abstract), gives an excellent summary of steam and binary vapor cycles. Dr. Gaffert's Fig. 12 (reproduced here as Fig. 1) shows that the heat rate of high pressure steam systems varies from 9500 to 12,000 B.t.u. per kw-hr., while the heat rate of mercury vapor-steam systems varies from 8600 to 9600 B.t.u per kw-hr.

Note, however, that the 1200 lb. steam stations, even with reheat to 1000 deg. F., have a minimum heat rate of 10,200 B.t.u. per kw-hr., and it is only the 3226 lb. with two reheats to 1000 deg. F. system which approaches the upper range of the mercury cycle. This high pressure steam system is not yet being considered and there is no doubt that it would be fully as complex as the present mercury vapor-steam plants.

I am enclosing temperature entropy diagrams (Fig. 2) for various high pressure steam and mercury steam cycles. The gain in useful work of the mercury over that of the high pressure, high superheat steam is clearly indicated on this temperature entropy diagram which shows that no matter how much the steam temperature is increased by superheating, an appreciable useful work area can always be added by superimposing the mercury cycle.

Schenectady, N. Y. E. S. Thompson.

Operating Codes for Modern Power Plants

In line with the timely articles on page 159 of the March and page 237 of the April issues, may I offer the following suggestions regarding stokers and Diesel operation? I do not mention the boiler, as the Operating Code compiled by Mr. Biggs covers boiler operation nicely.

Operating engineers are not, as a rule, technical men, and supervising engineers should see to it that plant personnel is given as much aid as possible in the form of personal advice, and all booklets and operating instructions that can be obtained from manufacturing companies.

Underfeed Stokers

1. Check fire for clinker formation, thin or heavy spots, contour, see if depth of fire is commensurate with boiler load. Check windbox pressures. Using stokers equipped with sectional control of forced draft, check each section separately.
2. Examine dump grates for breaks.
3. Check stoker setting for air leaks.
4. Check stoker mechanism for cracked or broken parts and faulty lubrication.
5. Check stoker drive and control apparatus for lubrication and free operation.
6. Check boiler setting for breaks, loose or fallen bricks, etc.
7. Report in full to shift foreman.

Diesel Engines

1. Check crankcase lubrication.
2. Check cylinder lubrication.
3. Check fuel pressure (mechanical injection) and air pressure (air injection).
4. Examine exhaust gas for color if possible and ascertain temperature of exhaust gas of each cylinder and outlet temperature of cooling water.
5. Listen at each cylinder for unusual sounds (booming, etc.), which would indicate (along with discrepancies in exhaust gas and water temperatures) incorrect loading of cylinder.
6. If relief cocks are installed, open each in succession. This will also give rough indication of combustion conditions in cylinder.
7. Examine fuel pumps, air compressors, water pump (if any) for condition.
8. Examine valve gear, governor gear, for mechanical condition, loose or tight parts, parts out of line, missing cotter keys or set screws.
9. Check air pressure in starting air bottles.
10. Use special precaution when checking lubrication of high pressure air cylinders.
11. Check oil cooler, centrifuge, filter, and screens in oil or water lines.
12. Use engine indicator and exhaust gas pyrometers freely to keep engine running economically. This last item should be left to one man only.

Detailed information as to the paralleling of generators, etc., should also be imparted to the operator but it need not be repeated as this field has been looked upon from time to time in the magazine.

Central Islip, N. Y. William A. Sheffer.

Repair to Tapered Valve Plugs

In a certain plant, several tapered valve plugs used for controlling beer and compressed air on a beer bottling machine were found to have worn approximately .02 in. under size. Since this resulted in considerable leakage a method of repair was decided upon. The plugs were machined slightly further under size and then knurled. Brass was then deposited over the whole surface about .03 in. thick. After this the plugs were ground to the size which they had originally been when new. This cured the trouble.

Kent, England. W. E. Warner.

Boiler Rating

I was much interested in the communication of N. T. Pef, on boiler ratings, in the May issue.

I am sure that from an academic point of view, most engineers will agree with his criticism, and it must be admitted that when we are dealing with high pressure boilers for large plants, such as those of the public utilities, nominal boiler horsepower has little significance, as the engineers of these companies know exactly what results they want to get and have a good idea as to the best way of getting them. They are accordingly in a position to draw up specifications which will cover the case without much regard for conventional ratings.

It will also be agreed that "boiler horsepower" is not a scientific term, but on the other hand, it has the advantage that every engineer knows what it means, and that is about the best that can be said for any term which might be chosen to replace it.

Of course the obvious criticism may be made, that boiler horsepower in its practical application has really two meanings, one describing the physical heating surface of the boiler together with its assumed ability to generate a definite minimum amount of steam, and the other designating an actual unit of evaporation, that is, 34.5 lb. "from and at" or a transfer of 33,479 B.t.u. per hour.

When used in the latter sense, as a unit of evaporation, the term is quite definite and tells us everything that any other term could tell. We may argue about whether or not some other term would be more appropriate, but it really does not matter very much, as every engineer knows exactly what a boiler horsepower of evaporation means.

From a business standpoint, the term boiler horsepower, or its equivalent, has some decided advantages.

For a number of years, the rating of cast-iron heating boilers was in a chaotic condition, the only bright spot in the firmament being the steel boiler which was rated on a horsepower basis with 10 sq. ft. to the horsepower.

When we specified a steel boiler, we knew pretty well what we were doing. We knew that we should get 10 sq. ft. of heating surface per horsepower, and that in practice, we could generally rely upon at least 34.5 lb. of steam per hour. As to whether we could get any more under the assumed operating conditions, that was a matter for personal judgment, based upon experience.

At the present time, with regard to the rating of cast-iron boilers, the conditions are somewhat better, at least we have more definite information as to what they are supposed to do, under certain hypothetical conditions, based chiefly upon the manufacturers' statements, but I still have a soft place in my heart for the good old horsepower rating of the steel boiler, though unfortunately there now appears to be a tendency to eliminate that, especially in the case of oil burners.

With power boilers, the conditions are somewhat similar to those of the steel heating boiler. If we buy a 100-hp. h.r.t. boiler we know exactly what we are getting. Just how much steam we may expect actually to generate under the conditions of its setting and firing, is, as far as I can see, a matter for individual judgment.

How we are going to do away with this, I do not know, unless we are willing to run a "free for all" competition, and take the claims of the different manufacturers at their face value.

Personally, that does not appeal to me, and I do not believe that it would appeal to the better class of boiler manufacturers. It opens the way for too much sharp competition. We had our experience with that practice with the cast-iron heating boilers.

When we consider water tube boilers, the situation is not quite so clear as with h.r.t. boilers, as there is more latitude in the disposal of the heating surfaces, but even here, the experienced engineer knows pretty well what can be done with 10 sq. ft. of heating surface under different conditions, and calling the 10 sq. ft. by some other name than horsepower, will not make any difference.

Of course, all heating surfaces have not the same value, and it might be helpful if the A.S.M.E. Boiler Code Committee, or some other generally accepted authority, would clearly define a standard square foot of heating surface, together with the relative values of other surfaces which did not conform. At the same time, I do not think that much practical difficulty is generally experienced along these lines, and it still remains a matter for personal judgment as to what we can do with our square foot when we have got it.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Boiler Plate Wastage

IN THE READERS' Conference Section of April Power Plant Engineering Mr. Warner raises an interesting point. He states that boiler plate wastage may occur through impingement of solid impurities which have leaked past the soot blower master valve, been deposited in the pipe and, afterwards, blown with great force against the plate when the soot blower steam is turned on. This wastage will occur at the point where steam first strikes, of course.

It is possible to remedy this condition with a minimum of effort. Between the master steam valve and the soot blower elements there is, or should be, a drain valve, at the lowest part of the line. This drain should be opened when steam is first turned on and closed before the elements are actually operated. In this way the elements are kept in good condition. If, however, an additional precaution is desired, file a small slot across the face of the drain valve seat so that there will be, at all times, a clear passage, though small, to waste. This will act as double insurance against wastage and the trifling loss of steam, if any, will be justified by results. Then, if the drain valve should not be opened, particles will escape through the small slot.

Rutherford, N. J. MARK BELL.

Slotting Brushes

WHEN IT IS NECESSARY to slot brushes of motors or generators, the slots should be cut axially across the contact surface. The slots should be about 1/16 of an inch wide and about 5/16 of an inch apart. The effect of slotting is to make the contact drop more uniform and to improve the distribution of current between the various sets of brushes. Where slotting is used, there is a slight reduction in the contact drop and a slight increase in the friction loss. The more efficient contact between the brush and the collector ring and the commutator, however, often enables the spring pressure on the brush to be reduced. Normally, a spring pressure of 2 lb. per sq. in. should not be exceeded where slotted brushes are used, especially on those machines which run on a light load for long periods of time. If this pressure is exceeded the increased friction loss, when combined with the low current density, may cause brushes to chatter. Slotting of brushes may present considerable advantages in cases where trouble due to flattening of the commutator or slip rings has been experienced or in cases where sparking or blackening occurs when the brush stability is under suspicion.

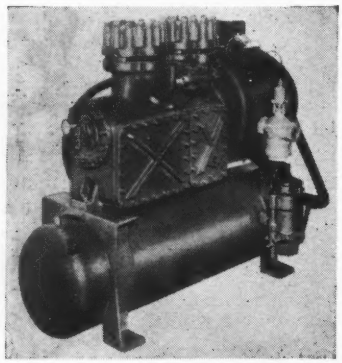
Kent, England. W. E. WARNER.

New Equipment

Westinghouse Develops Air Conditioning Unit

WESTINGHOUSE ELECTRIC & MFG. CO. have developed a new line of hermetically sealed units for use with air conditioning systems. The outstanding features of these units, which are known as the CLS line, is that they are completely enclosed. The driving motor is enclosed, forming an integral part of the compressor, and no seal or stuffing box is required as in the usual type of unit. This sealless line was developed after making a thorough study of the operating troubles and service requirements of conditioning units available on the American market. This analysis showed that the most serious troubles experienced with all machines in operation were due to the failure of the seal through which the driving shaft enters the compressor. Approximately a half million dollars has been spent in equipping and developing a 40,000 sq. ft. factory at Springfield, Mass., to manufacture the new line of compressors.

These units are being made with nominal rating from 7 to 22 tons cooling



capacity. The rotor of the driving motor is over-hung from the main rear compressor bearing on a short, stubby extension of the compressor crankshaft. This gives an ultra compact direct drive, avoids ever having to oil the motor and eliminates the use of belts and pulleys. The motor is water cooled, making the unit suitable for installation in unventilated locations.

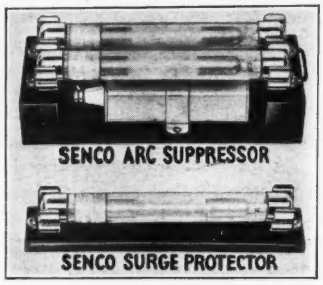
As a result of these and other unique features, the hermetically sealed units are more compact, lighter in weight and require less maintenance than conventional designs. Only one external pipe connection is necessary. This produces a pleasing appearance and reduces the possibility of leaks, simplifies field installation since few connections are required. Positive lubrication is obtained by the use of a single oil pump providing complete distribution of oil to every part of the unit. The pump is direct driven from the main crankshaft by means of a noiseless micarta gear. The series parallel condenser manifold permits efficient use of either city water or cooling tower.

Since no mechanism of this size of air conditioning unit can be completely free of the occasional necessity for mechanical adjustment, provision is made for making these adjustments through side service plates. The entire operating mechanism of the CLS units can be exposed by removing the side plates from the crankcase casting. No refrigerant or water lines need to be disconnected to service the interior of the unit. It is claimed by the manufacturers that for equal cooling capacity, the new hermetically sealed conditioning units occupy less floor space and weigh less than any conventional design now on the market.

Electronic Surge Protection

A NEW LINE of gaseous discharge tubes has been developed by the Sundt Engineering Company of Chicago, Illinois, affiliate of Littelfuse Laboratories, for surge protection and arc suppression in highly inductive circuits, especially direct current.

The principle of operation is that in a gaseous discharge tube no current flows until the voltage applied is sufficient to ionize the gas, it then becomes a good conductor. The tubes are rated for use in 125, 250 and 500 volt d.c. circuits and calibrated so that no load is placed upon the normal circuit. When the surge potential, due to the opening of a switch for instance, rises above normal, the tube ionizes and shunts out the surge. The tubes are ordinarily placed in shunt with the coil or magnet between the switch and coil and reduce the coil potential to normal within .010 to .1125 seconds after the circuit is opened. The very high instantaneous current carrying capacity of a discharge tube is also utilized.



The protectors are offered in two current carrying capacities; the Junior line with a peak load value of 10 amp. and a Heavy Duty line with a peak value of 100 amp.

A line of Arc Suppressers is also offered which is a combination of a surge protector tube and a condenser. It is well known that capacity is usually very helpful in arc suppression and by using the gaseous discharge tube in parallel with the coil a lower voltage rating of condenser is possible with resulting economies. These units are furnished only in the Heavy Duty type.

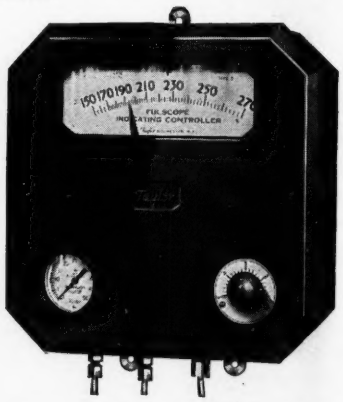
Coil failures are often initiated by insulation failures due to high self induced surges. The use of these protectors and arc suppressers practically eliminates this type of failure and also permits a lower safety factor on initial installations. Surge protectors may also be used very effectively for protection from lightning surges and static potentials.

An interesting folder is available from Sundt Engineering Company showing by means of oscillograms the comparison between the various forms of protection for inductive circuits.

Taylor Controllers

FOR PROCESSES where close throttling control is imperative but a record of the processing is not essential, the Taylor Instrument Companies, Rochester, N. Y., have just put on the market a moderately priced, highly adaptable, air-operated controller of the indicating type.

Many features of this new instrument previously have been available only in the Taylor Fulscope Recording Controllers; hence the name, Fulscope Indicating Controller. The outstanding features are as follows:



Either high-range or full-range sensitivity, as required. The former for processes having small time lags; the latter for time lags of any magnitude. Both are fully adjustable by turning a graduated dial.

The control point may be adjusted to any value within the control range. Direct-set feature is optional.

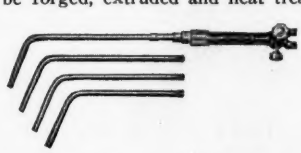
Controller action may be quickly reversed in the field by altering the position of a link.

Many standard control ranges to choose from within the limits of minus 100 and plus 1200 deg. F., or full vacuum and 3000 lb. pressure. Control ranges are interchangeable.

Temperature controllers may be equipped with mercury, vapor, or gas-actuated tube systems.

Welding Torch

MODERN ENGINEERING COMPANY, St. Louis, makers of Meco Oxy-Acetylene Welding Equipment, have developed a new weldmaster light weight welding torch. This torch with a standard tip weighs only 17½ oz., and is claimed by the makers to be the lightest weight torch on the market. A new alloy that can be forged, extruded and heat treated



and has a tensile strength of mild steel is used in the construction. According to the makers the torch is perfectly balanced as a result of weight elimination and can be manipulated by the operator with maximum flexibility and minimum effort.

The circle mixer employed in all Meco

torches has been improved and its capacity increased. Even the largest tips may be used efficiently with low gas pressures, as when working from medium acetylene generators. A new method of boring passages to rifle smoothness has been developed in this torch. Ideal flame characteristics under any operating circumstances in the full range of welding practice are claimed.

Other features are:—spring-tension equipped wheel handles which assure permanent adjustments even with rough handling and bumping of the torch. Wheel handles are fluted design and grip is thin with wide fluting. Handle is finished in a combination of blue and contrasting natural silvery metal, polished to a high lustre.

Pressure Switch

A NEW PRESSURE SWITCH for the automatic control of small compressors and fluid pumps is announced by Cutler-Hammer, Inc., pioneer manufacturers of electric control apparatus, Milwaukee, Wis. Outstanding features of this switch are its compact all-metal "airstyled" enclosing case; flexibility of application, long, trouble-free operation; full automatic action; protection to motor; ease of wiring, adjusting and inspecting.

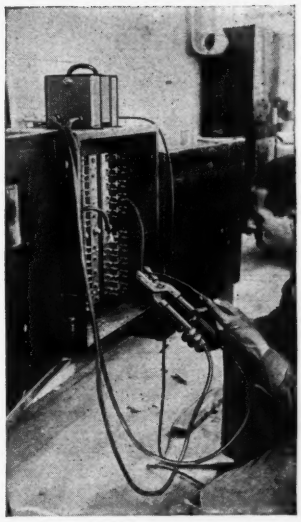
Pressure connection for S.A.E. fitting is furnished as standard, but may easily and quickly be converted into ¼ or ⅜-in. pipe fitting. Although the switch is completely new in design, the basic mechanism is time-tested by millions of instal-

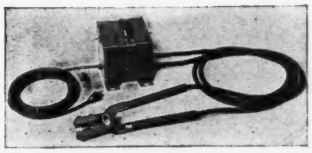
lations in domestic refrigerators. Inverse time limit overload protection is obtained by the C-H Eutectic Metal Thermal Overload Relay, operating directly on the contact mechanism. The relay gives protection to the motor during starting and running—allows an ample time interval to take care of starting inrush and momentary overloads without tripping. A red band on the reset button indicates when the switch is open and equipment shut down; pressing the button resets the overload, places the starter back in service. By simply pulling out the reset button the equipment can be shut down. The split type enclosing case and design of the mechanism permits easy access to terminals and adjustment screws. The case is easily removed by loosening one self-locking type screw.

New Hot-Jaw Pliers

A NOVEL and unusual portable electric tool has been added to the line of motor maintenance equipment and electrical specialties made by the Ideal Commutator Dresser Co., 1006 Park Ave., Sycamore, Illinois.

The unit illustrated is an electric heating tool called "Thermo-Grip" Pliers, which takes the place of an open-flame blow torch or burner. When the wire con-





nections are plugged into any a.c. lighting circuit, current passes through the Transformer and rapidly heats the jaws to a white-hot temperature.

This tool has numerous applications in the industrial field. In production work, it is used for small soldering and heating jobs otherwise requiring a cumbersome blow torch with open flame. The tool, also, serves many purposes in plant maintenance—installation, changes or repairs to wiring, piping, etc. It can be used to heat a solder cup or thimble, or for applying or removing the solder joints of threadless copper pipe, tubes and fittings.

These pliers have renewable carbon jaws, insulated fibre handles, and a "Hi-Lo" heat control and "Off-On" switch. Current is supplied from any a.c. line. Current is only consumed when pliers are being used.

The entire unit is portable, weighing 14 lb., is safe, shock-proof and sturdily built. The cord connection is 10 ft. long. Two 6-ft. lengths of heavy duty cable connect the transformer and pliers, allowing plenty of freedom for workers' movements.

Vacu-Break Switch

THE BULL DOG Electric Products Co., Detroit, Michigan, have developed a new safety switch which they call the "Vacu-Break." In this switch the conventional procedure is reversed and the arc extinguishing structure is placed on the moving contact (blade) instead of on the stationary contacts. This feature together with other features results in an unusually high circuit rupturing ability.

The arc extinguisher is made in the form of a partitioned chamber, totally enclosed except for 2 slots at the bottom to receive the dual stationary contacts in separate cells. This chamber (in which the moving contact is floatingly supported) moves with the moving contact in and out on the stationary contacts, as guides.

According to the claims of the manufacturer the piston action of the contacts when rupturing in this close fitting arcing chamber tends:

(1) To evacuate the small amount of air present in such a restricted enclosure, thus minimizing burning of the arc chamber or the contacts, by reducing the oxygen available to support combustion.

(2) This restricts the amount of ionizable gas present to conduct the arc incident to rupturing the circuit; and the close-fitting arc chamber is the efficient de-ionizing medium for what little ionization does occur.

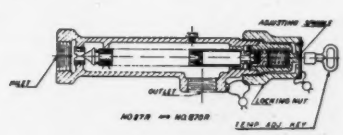
According to the manufacturer's statements regarding the tests on these switches, they have remarkable overload capacities. In one case, a small 60 amp. 3 pole Vacu-Break switch successfully broke a load of 1000 amp. 460 v. 33 per cent power factor. The load was a 125 hp. motor with stalled rotor. A typical severe endurance test was the case of a 200 amp., 575 v., 3 pole switch which was operated 12,000 times at 75 per cent power factor under full rated load.

The switch is made in three complete lines: Master (type A), Standard (type C) and Junior (type D).

Sarco Thermoton and Trap

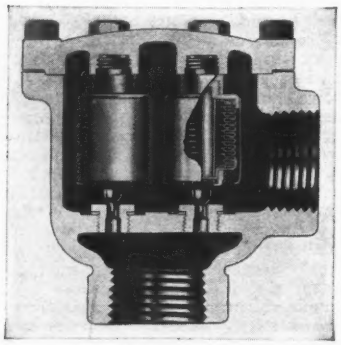
SARCO CO., INC., 183 Madison Avenue, New York City, announce a new temperature control valve for jacketed kettles, open or closed tanks and other steam heated process equipment.

This new valve is operated by liquid expansion and will be known as the Thermoton. It is intended to provide approximate temperature control by automatically varying the flow of steam to the heating coil or jacket. Thermotons can also be used on the steam outlets from jackets, chests or coils, in place of ordinary steam traps. They can be adjusted to discharge the condensate at any temperature desired, down to 90 deg. F. In this way they hold back part of the condensation, thus acting as temperature regulators.



As the cost is low they make automatic temperature control available for many processes for which it has hitherto been considered too expensive. Another development just placed on the market is

the new multiple bellows thermostatic trap also illustrated. It is intended for use in removing condensate from large steam coils or jackets, requiring considerable capacity. This makes available for large units the thermostatic principle for which the makers claim important economies in steam consumption for all heating and processing applications. It adapts itself



automatically to variations in the rate of condensation. The new trap is made in sizes 1¼ to 2 in. in two pressure ranges, 0-60 lb. and 0-200 lb. Separate valves are provided for each bellows. Seats and discs are of stainless steel.

Rubber Protects Turbine Buckets

To OVERCOME TROUBLES caused by cavitation of the buckets of this large water wheel, it was finally coated with a rubber compound developed by The B. F. Goodrich Co., Akron, Ohio. This has proved highly satisfactory. The buckets in this 15 ft. diameter wheel are made of ⅞ in. steel but, formerly at the end of approximately three months they would be honeycombed with scores of large holes and cavities which necessitated their replacement. Various protective measures were tried without success, until this rubber compound was developed by the Goodrich engineers. The buckets were first given one coat of rust inhibiting primer followed by a single coat of self vulcanizing cement. They were then given three coats of a special liquid rubber compound. Although this protective covering is only about .003 in. thick, the steel buckets have already lasted seven months and, apparently are good for many more.

Armstrong Cork to Sell Glass Insulation

CONSUMMATION of a selling arrangement whereby the Armstrong Cork Products Company will act as sales agents in the equipment insulation field for the Corning Glass Works' new highly refined wool insulation consisting of long, interlocked glass fibres, is announced by L. E. Cover, manager of Armstrong's Equipment Insulation Sales Department.

Armstrong will sell this efficient material under the trade name "Armstrong's Wool Insulation" and it will be furnished in the form of sealed packages, blankets, fold-bats, and in bulk or loose form for use as a fill insulation.

Tests made by the Armstrong research laboratories show that the insulating wool possesses unusually low thermal conductivity, ranging, in the commercial densities, from 0.23 B.t u. to 0.26 B.t.u. per hr. per deg. F. at 90 deg. F. mean temperature. Especially long, intertwined fibres give the insulating wool blankets strength. Since the insulation holds together, it will not shake down or settle under extreme vibration. Depending on the temperature requirements the new wool insulation can be furnished in forms weighing from 1½ to 6 lb. per cu. ft. Since it contains no "shot" or other non-insulating materials that add weight, it is especially suitable for use where reduction of weight is essential. Like other glass products, this insulating material is chemically stable and permanent, is sulphur-free, is not affected by moisture, and is not subject to the action of mold or fungi.

Working with the research department of the Corning Glass Works, Armstrong's research laboratories have developed fabricated forms of this wool which Armstrong's special knowledge of the equipment insulation field has indicated are required.

Korduct

TRANSITE KORDUCT, a new thin-walled companion to Transite Conduit, has just been announced by Johns-Manville after several months of development work which include a number of successful field installations.

Korduct, identical with Transite Conduit except in thickness, is an asbestos-cement product formed under high pressure on a polished steel mandrel which assures an absolutely smooth inner surface.

Transite Conduit was created more than 2 yr. ago to provide a conduit sufficiently strong and resistant to enable the laying of underground duct systems without a concrete protective envelope, and also to provide permanence in an electrical conduit used in exposed locations.

Korduct has now been introduced in its thin-walled form to enable the economical application of Transite's permanence and other inherent qualities to duct systems that are enclosed in concrete. Korduct is rot-proof and incombustible. It is immune to electrolysis and highly resistant to all forms of corrosion. Its rate of heat dissipation is high and cables are easily pulled through its smooth interior. This new material is recommended for use on all multiple duct transmission systems, in tunnels, bridge structures or dams, and wherever the service calls for concreting in.

Williams Ratchet Wrench

"SUPERECTOR" is the name given by J. H. Williams & Co., 75 Spring St., New York City, to a new line of heavy duty reversible ratchet wrenches just put on the market. The outstanding features of these wrenches are: Quadruple pawls, instead

of the usual two, provide double bearing and strength with greatly increased durability. Handles are drop-forged, to utilize the extra strength afforded by the pawls.

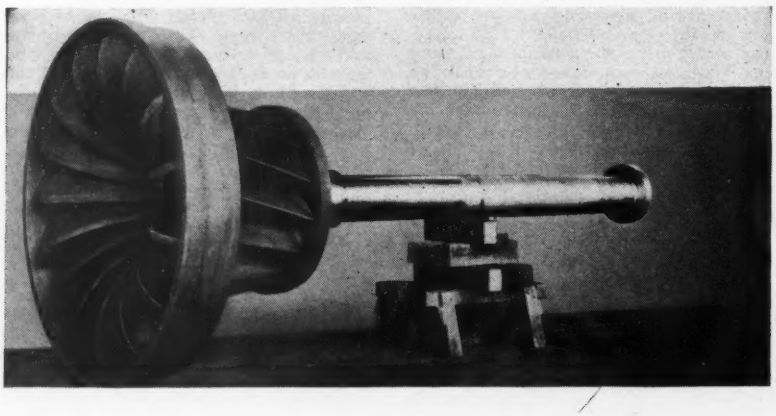
The new Williams' "Superector" is made in 5 sizes—24 to 48 in. Both hex and square sockets, with hole extending clear through, openings 1⅛ to 4⅝ in., turn nuts on any length of bolt.

Nalco Densimeter

THE NALCO DENSIMETER or small floating bulb, developed by the National Aluminate Corp. 6216 W. 56th Place, Chicago, Ill., is a convenient and accurate device for determining boiler water concentration by the density method. The densimeter is exceedingly light in weight and is extremely sensitive to changes of concentration of solids in the boiler water. This sensitiveness ensures accurate determinations. Also because of its size,

it is conveniently handled and carried.

In making a determination the small floating glass bulb is placed in a beaker of warm boiler water where it will sink to the bottom of the sample. The water is stirred with a special thermometer graduated in grains per gallon, and as the water cools a point is finally reached when the bulb will float. The concentra-



tion of the boiler water is then read direct from the specially graduated thermometer. Range 25-500 grains per gallon.

For convenience, the glass bulb is encased in a metal container that can be attached to a watch chain and the thermometer has a clip so that it may be carried in a pocket.

Micro-Westco, Inc.

ANNOUNCEMENT is made by the Westco Pump Corp., Davenport, Iowa, that negotiations have been completed which will merge the Westco Pump Corp. and The Micro Corp. of Bettendorf, Iowa. This action was recently agreed upon by the stockholders of both concerns which long have been affiliates of The Bettendorf Co.

The new concern will be known as Micro-Westco, Inc. with offices located in the Bettendorf Office Building in Bettendorf, Iowa. Work will soon commence to move the Westco manufacturing equipment and stocks to the Micro factory in Bettendorf where plant addition is already under construction.

Organized in 1919 as the Western Pump Co. to manufacture a turbine-type pump, the firm name was changed to Westco Pump Corp. in 1930.

The Micro Machine Co. was founded in 1922 to engage in the manufacture of grinding machines. Later the name was changed to The Micro Corp. when this firm started manufacturing and selling Bettendorf oil burners, ice crushers, and Slice Master bakery equipment. No changes are contemplated in the personnel of either the Micro or the Westco organizations.

Hewitt Members Honored

AT THE ANNUAL ORGANIZATION meeting of the Board of Directors of the Hewitt Rubber Corp. recognition was given to the outstanding work of members of the Hewitt organization. Thomas Robins, Jr. was honored with the title of President, I. G. Cooban, Vice-President and E. K. Twombly, Vice-President and Treasurer, and J. H. Hayden, Secretary.

Thomas Robins, Jr., son of the inventor of the troughed belt conveyor, started in the employee of the Robins Conveying Belt Co. in 1919, and successively became advertising manager, and then assistant sales manager. The Robins Conveying Belt Co. acquired control of the Hewitt Rubber Co. and its subsidiary, the Gutta Percha and Rubber Mfg. Co., in 1926, and Thomas Robins, Jr. moved to Buffalo to become assistant to the president of the new company. The following year he was elected Vice-President, and in 1931 he was also designated General Manager.

Westinghouse Appoints Engineering Manager

APPOINTMENT OF M. W. SMITH as Manager of Engineering is announced by Dr. S. M. Kintner, Vice President of the Westinghouse Electric and Mfg. Co.

Mr. Smith has been associated with Westinghouse since 1915. Then a recent graduate of Texas A. & M. College, he joined the company as a student engineer and has since been continuously identified

with generator engineering operations, first as design engineer, later as a section engineer and more recently in charge of the design of the large rotating alternating current machinery of the generator division.

He will maintain his new office at the Westinghouse East Pittsburgh headquarters.

To Stop Smoke

ORGANIZATION of the Industrial Smoke Abatement Association of Hudson County, New Jersey, was completed on May 22, 1936, according to an announcement by William G. Christy, Smoke Abatement Engineer of Hudson County. The organization meeting was held at Stevens Institute of Technology, Hoboken. This Association was formed to coöperate with the Hudson County (N. J.) Department of Smoke Regulation and to work for further elimination of smoke from industrial plants in the county.

The announcement states that this is the first time in the United States that a group of industries has organized for the purpose of eliminating smoke. The principal reason Hudson County plants have formed this group is that plant owners and executives realize the substantial fuel savings which can be accomplished by abating smoke. The greatest value the new Association will have for its members is that it provides a forum for exchange of ideas.

More than one hundred industries having plants in Hudson County have already affiliated with the Industrial Smoke Abatement Association and the Association expects to hold meetings every 60 days.

Names of officers and directors elected at the meeting are as follows: President, A. W. Akins, Supt. of Power, Standard Oil Co. of N. J., Bayonne; First Vice President, G. H. Binder, Vice-President, Woburn Degreasing Co., Harrison; Second Vice President, W. L. E. Keuffel, Secretary, Keuffel & Esser Co., Hoboken; Third Vice-President, J. S. Hollowell, Supt., Natural Prod. Ref. Co. Jersey City; Fourth Vice President, M. Edward Verdi, President, Verdi Bros., Cooperage Co., North Bergen; Secretary, H. Yunker, Chief Engineer, Jersey City Printing Co., Jersey City; Treasurer, John Gerhard, Chief Engineer, Swift & Co., Kearny; Directors, James W. Ames, President, W. Ames & Co., Jersey City; J. H. Brautigam, Gen. Supt., Worthington Pump & Machinery Corp., Harrison; E. S. Bell, Supt., United Africa Co., Guttenberg; L. P. Goodwin, Manager, Mallinckrodt Chemical Co., Jersey City; J. A. Jacobs, Plant Engineer, Colgate-Palmolive-Peet Co., Jersey City; G. H. Koven, President, L. O. Koven & Bros., Jersey City; F. D. Lohr, Supt., Koppers Gas & Coke Co., Kearny; Wm. Olsen, Supervisor Power Plants, New York Central Railroad, N. Y.

A.S.T.M. Officers

AT THE FIRST SESSION of the A.S.T.M. Annual Meeting at Atlantic City, officers for the coming year were announced. A. C. Fieldner, Chief Engineer, Experiment Stations Division, U. S. Bureau of Mines, Washington, D. C., was elected President, and T. G. Delbridge, Manager, Research and Development Dept., The Atlantic Refining Co., Philadelphia, Pa., Vice-President.

Following were elected members of the Executive Committee: O. U. Cook, Assistant Manager, Dept. of Metallurgy, Inspection and Research, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala.; H. F. Gonnerman, Manager, Research Laboratory, Portland Cement Assn., Chicago, Ill.; C. S. Reeve, Manager, Research Development, The Barrett Co., Leonia, N. J.; F. E. Richart, Research Professor of Engineering Materials, University of Illinois, Urbana, Ill.; F. M. Waring, Engineer of Tests, The Pennsylvania Railroad Co., Altoona, Pa.

Mr. Fieldner graduated from Ohio State University in 1906 and after a short time with the Denver Gas & Electric Co., became Fuel Chemist in the U. S. Geological Survey at Pittsburgh. In 1910 this work was transferred to the newly created Bureau of Mines. During the war he was a Major in charge of the Gas Mask Section, Chemical Warfare Service. After the war he was placed in charge of the Pittsburgh Station of the Bureau of Mines and in 1925 appointed Chief Chemist. In 1927 he was placed in administrative charge of the Bureau's Experiment Station's Division with headquarters at Washington, D. C.

At the same convention, H. C. Mann, Senior Materials Engineer, Ordnance Dept. U. S. Government, Watertown, Arsenal, was awarded the Charles B. Dudley Medal for 1936. This medal, which commemorates the name of the first A.S.T.M. president, is awarded to the author of the paper presented at the preceding annual meeting which is of outstanding merit and constitutes an original contribution on research and engineering materials.

The winning paper was entitled, "The Relation Between the Tension Static and Dynamic Tests." Correlation of these tests involves consideration of the fact that the material in its initial state possesses a certain amount of inherent potential energy which, during the process of deformation, is apparanetly converted to kinetic energy and is manifested as increased elastic strength.

News From the Field

PROFESSOR DUDLEY P. CRAIG, associate professor of mechanical engineering at Purdue University, and a member of the Purdue staff since 1921, has tendered his resignation effective August 8, to accept a post as professor and head of the Mechanical Engineering Department of Colorado State College of Agriculture and Mechanics Arts at Fort Collins, Colo. He will assume his duties there September 1 and will move his family to the western city the latter part of August.

MORRIS MACHINE WORKS of Baldwinsville, New York, announces that changes in its executive personnel, incident to the death of Windsor Morris, have resulted in the election of Carl Lager as President, and Pierce J. McAuliffe as Vice President and General Manager. Carl Lager joined the organization as its chief engineer 46 yr. ago, and during this period he has been a leading factor in the remarkable advance in the development and application of centrifugal pumps. Pierce J. McAuliffe joined the company in 1910 as designer of hydraulic dredging equipment. During the War, he was with the Construction Division of the Emergency Fleet Corporation, becoming Manager of Ship Construction in 1918. He rejoined Morris Machine Works in 1920, and continued as representative in the New York Office until taking up his new duties at Baldwinsville.

THE AIRETOOL MFG. CO., Springfield, Ohio has moved into its new home which now gives it 10,000 sq. ft. of floor space, all on one floor. Airetool's machine shop plant is equipped with all new machinery of latest design. Included in the new layout is an up-to-date hardening plant and thorough testing equipment.

ISAAC FIDLER, for 27 yr. in charge of power plants for the Stehli Silks Corp., has opened a consulting engineering office at 217 Willowbrook St., High Point, N. C. His services are available as a consultant in power plant engineering, electrical equipment, Diesel engines, appraisals, machinery layouts, lighting and power surveys.

DURING THE WEEK of November 30, the Twelfth National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace in New York under the management of the International Exposition Co. Visitors to the eleventh show held in 1934 numbered 35,690 and came from 1036 cities and towns in 41 states, 55 towns in 26 foreign countries and 5 towns in United States possessions.

REPUBLIC STEEL CORPORATION, Cleveland, Ohio, announces that Julius Kahn has been appointed Vice President in charge of the Production Department, having recently resigned his position as President of the Truscon Steel Corporation, which he founded some 33 yr. ago.

IRON FIREMAN MANUFACTURING CO. announces that Karl E. Saboe has been promoted from district representative to the newly created position of Industrial Sales Manager in the general sales department, Cleveland, O.

C. M. TATE formerly with Askania Regulator Co. has joined Hagan Corp., Pittsburgh, Pa. Mr. Tate, has specialized in the application of combustion control to metallurgical furnaces in the steel mill industry and his work with Hagan Corp. will be along similar lines. He will have his headquarters at Pittsburgh but will coöperate with the various Hagan Corp. offices in other territories in contacting the steel mill industry.

JULIEN P. FRIEZ & SONS, INC., Baltimore, Md., have recently appointed the following factory representatives: W. L. Byrne, 4 Smithfield St., Pittsburgh, Pa., and Russell R. Cannon Co., 519 Main St., Cincinnati, Ohio.

AT THE RECENT Hot Springs Convention of the Air Conditioning Manufacturers Association, John F. G. Miller, Vice President of B. F. Sturtevant Co., was elected president and member of the Board of Directors.

EDWARD A. LIVINGSTONE has recently been appointed Manager of Alloy Tube Sales for The Babcock & Wilcox Tube Co., Beaver Falls, Pa. Prior to this appointment, Mr. Livingstone was engaged in the development and introduction of special B&W high-temperature, corrosion-resistant alloys to the oil industry in the United States.

Before becoming connected with The Babcock & Wilcox Tube Co., in January, 1933, Mr. Livingstone was successively District Sales Manager for the A. O. Smith Corporation in Los Angeles, Tulsa, and New York City. This experience and that acquired in the last 4½ yr. with The Babcock & Wilcox Tube Co. in special sales work in the oil industry, gives Mr. Livingstone a broad background for his new position.

AMONG AUTHORS to be heard at the third World Power Conference to be held in Washington, D. C., Sept. 7 to 12, will be: Floyd L. Carlisle, a New York banker and Chairman of the Board of the Consolidated Edison Co. of New York, outlining his idea of the basis for a permanent national policy on power and power resources. Stuart Chase, economist and W. S. Finlay Jr., president of West Penn. Electric Co., on Planning for Conservation of National Resources. Basil Manly of the Federal Power Commission and Geo. N. Tidd, president American Gas & Electric Co., on Regional Integration of Electric and Gas-making Facilities. The two Morgans of T.V.A. fame, one on Planned Utilization of Water Resources, the other on Rural Electrification. James C. Bonbright of the New York Power Authority, William E. Mosher of Syracuse University and John E. Zimmerman, president United Gas Improvement Co. on Public Regulation of Private Electric and Gas Utilities. All these men have had wide experience in the subjects on which they will speak, hold firm opinions and are prepared to defend their positions.

TOMLINSON STEAM SPECIALTY CO., Cleveland, O., has been appointed sales representatives for The Edward Valve & Mfg. Co., Inc., East Chicago, Ind.

ROBINS CONVEYING BELT CO. has recently made a sales agreement with the Mine and Smelter Supply Co. of Denver, Colo., Salt Lake City, Utah, and El Paso, Texas, for the sale of Robins equipment in the states of Arizona, Colorado, Montana, New Mexico, Utah and Wyoming, and in parts of Idaho, Nebraska, So. Dakota and Texas.

A UNIQUE MOTION picture film entitled "Super-Refractories through the Microscope" has been developed by the Research Laboratories of the Carborundum Co. and is available for showing before interested technical societies. The first part of the film was made by the Kodachrome process and shows the structure of various refractory materials as they are revolved on the stage of the polarizing microscope. The second part of the film was made by means of the newly developed thermal microscope and gives a graphic demonstration of the actual behavior of various types of refractories under severe operating conditions. Interested societies can arrange for showings through the Refractory Division of the Carborundum Co., Perth Amboy, N. J.

L. W. GROTHAUS was recently elected vice-president of Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mr. Grothaus has had 32 yr. of wide experience with the Allis-Chalmers organization, working successively in the Norwood Shops, the purchasing, drafting, engineering and sales divisions and then becoming district sales manager first of the Minneapolis office and later of the Cleveland office. During the War he was made a member of the War Industries Staff. In 1925 he became assistant manager of the electrical division, first at Norwood and later at Milwaukee, being made general representative of the company in 1931 and assistant to the president since 1933.

GEORGE M. SNODGRASS has recently been appointed general sales manager of The Imperial Electric Co., Akron, O. For the past 15 yr. Mr. Snodgrass has been with Fairbanks, Morse & Co., where he advanced to the position of general sales manager of the electrical division. He is well known in the electrical industry for his technical knowledge of motors and control and for his active work with the National Electrical Manufacturers Association.

For the Engineer's Library

LEGAL AND ETHICAL PHASES OF ENGINEERING. By C. Francis Harding and Donald T. Canfield. First Edition, 6 by 9 in., cloth, illustrated, 431 pages. McGraw-Hill Book Company, Inc., New York, N. Y. 1936. Price $4.00.

Smith, a consulting engineer, receives a telephone call from a party whom he believes is Brown, when in fact it is Allen, asking Smith to specify a certain interior lighting scheme for his factory. Smith goes to Brown's factory, collects the necessary data and makes the design—all unknown to Brown. He later sends the specifications and plans to Brown. As it happens, Brown was also contemplating a change in his lighting and uses Smith's specifications. Is Brown liable to Smith for the price of the design?

The answer is yes. Although there has been no contract between Smith and Brown, the law implies a contract if Brown accepts the benefits.

This case is typical of many others discussed in this very interesting and valuable book.

To most human beings the law is a necessary evil. We avoid it as much as

possible and when we do become involved in it find its proceedings distasteful. Many engineers, probably, are similarly inclined, but an engineer by virtue of his dealings with the world of business, the fact that he must make and accept and discharge contracts or take out and consider patents, etc., should know, at least, the fundamental aspects of the law, for sooner or later he will find himself involved in legal phases of engineering.

As stated by the authors, in the preface, the subject matter of this book has been used for many years in a second-semester senior engineering course at Purdue University in the attempt to acquaint every student with some of the most important legal and ethical principles with which he must be familiar before he can be successful in his business relations with other engineers, his superiors, employees and colleagues and with the public at large.

To the reviewer's rather unlegal temperament, the material in this book seems well ordered and it is presented in a clear concise manner.

The book is divided into four parts as follows: Part I, Legal Status (Contracts); Part II, The Engineer and the Law; Part III, Auxiliary Legal Relations; Part IV, The Engineer and Society. It concludes with a number of useful appendices.

The authors are both members of the faculty at Purdue University, Prof. Harding being the head of the school of electrical engineering and Prof. Canfield, associate professor of electrical engineering.

EXPLORING IN PHYSICS. By Reginald J. Stephenson. Published by The University of Chicago Press, Chicago, Ill. Size 6½ by 9 in., paper bound, 201 pp. Price $1.50.

Occasionally, very occasionally in fact, a new approach is made to an old problem and the rest of the world leans back with self-conscious wonderment as to why such a simple and obvious method was not tried years ago. Those of us who studied physics in high school, college or at home in the days when physics was a dry and dusty subject not to be taken lightly, may be somewhat surprised by Dr. Stephenson's treatment. One must admit, however, that a bathing beauty reclining on the bottom of a swimming pool and gazing at the sun forms a very effective, if unconventional, demonstration of refraction.

When the University of Chicago changed to the much discussed new plan a few years ago the new type of general introductory science courses involved the presentation of the fundamentals of each of the sciences to large numbers of students with no previous background or interest. This book (together with From Galileo to Cosmic Rays by Harvey B. Lemon) is used in the physics course as a text.

Dr. Stephenson, whose interest in X-ray and cosmic ray research is shared equally with his interest in seeing that all students acquire a fundamental knowledge of physics and do it in such a way that the effort is enjoyable and stimulating, says, "The science of physics has advanced as far as it has partly because its followers have found it so interesting. You will be able to discover some of this fascination if you will but try. . . . You must, however, be willing to spend some time and effort in this exploration, for there is no royal road to knowledge."

The book covers the fundamentals upon which the power plant is built and covers it practically without mathematics. Arithmetic, of course, is necessary and a little algebra is a help in working the examples but the principles are explained so clearly and the illustrations so apt that no one with ambitions to be an engineer should pass up the opportunity of thoroughly studying this book. And if you consider yourself a full fledged engineer with a thorough grounding in fundamental physics try and answer some of the questions without referring to the answers in the back. You'll be surprised to find out that you only think you know a lot of things. The problems are not complicated and not involved but they are fundamental and require logical thinking based on fundamental knowledge.

Chapter headings are: Speed and Acceleration; Newton's First Two Laws of Motion; Addition of Vectors, Projectiles; Newton's Third Law of Motion; Work and Energy; Atmosphere and Hydrosphere; Temperature and Expansion; Heat; Molecular and Kinetic Theory of Matter; Electric Charges and Magnetic Poles; Conduction of Electricity in Liquids and Gases; Wave Motion; Sound; Light; Electromagnetic Radiations, Waves and Particles.

This is a small book, it is reasonable in price, it is enjoyable reading and should be on the desk (not in the library) of every engineer in the country from the highest to the lowest.

CAUSE AND PREVENTION of Steam Turbine Blade Deposits by Frederick G. Straub is the title of a report of an investigation conducted by the author. It is published as Bulletin No. 282 of the Engineering Experiment Station, University of Illinois, Urbana, Ill., and sells for 55 cents.

There are several types of deposits which form on turbine blading, one type apparently being caused by deposition of solids carried in the steam from the boiler and another caused by chemical reaction between chemicals in the steam and material in the turbine blades. The report covers 50 pages and discusses the problem and solution in considerable detail. The basic material causing the fouling has been found to be sodium hydroxide and certain inorganic and organic salts may be used as a preventative.

RELAY SYSTEMS, THEORY AND APPLICATION. First Edition, by I. T. Monseth and P. H. Robinson. 549 pp., 6 by 9 in. cloth; fully illustrated. McGraw-Hill Book Co., Inc., New York, 1935. Price $6.

This book which is written jointly by a general engineer of the Westinghouse Electric and Mfg. Co. and an engineer of the Houston Lighting and Power Co., is a complete treatise on the theory and application of relay systems. The volume was developed from a series of articles which appeared in the Electric Journal during the years 1930 to 1932. The original presentation, however, has been completely rewritten, expanded and rearranged to include a complete treatise on the theory and application of relay systems.

The book seems to be very well planned. Believing that no real progress can be made in the development of relay systems without basing it upon a thorough quantitative analysis of the magnitude and relation of currents and voltages, the authors have attempted to give a practical system of all calculations for all arrangements of system connections and all types of short circuits. Six chapters have been devoted to a complete analysis of fault calculations. For unbalanced fault calculations, the fundamental system of symmetrical components is presented. Numerous examples are given which should be of value not only to practicing engineers but also to students and teachers in engineering schools and colleges. Relay systems and relative application data are completely covered.

The recent developments in high speed relay of the distance, balanced differential, pilot wire and carrier current types are fully described. A discussion of instrument transformer characteristics, vector analysis, wave form and testing is included.

Any one concerned in any way with the design, testing or maintenance of relay systems should find this book valuable and helpful.

MACHINE DESIGNERS' GUIDE. By K. W. Najder. Published by Edwards Bros., Inc., Ann Arbor, Mich. Size 5½ by 8½ in., 184 pp., planographed, cloth bound. Price $2.50.

Handbooks, as a rule, are of little use to those unfamiliar with the field. The presentation in this book is unusual and is intended to give mechanical engineers, machine designers, draftsmen, inventors and students sufficient information for calculations in the machine design field, without involving higher mathematics.

It is divided into five sections, the first, entitled Tables and Construction of Curves; second, Mechanics; third, Graphics; fourth, Strength of Materials; fifth, Examples. All the formulas are numbered for easy reference to enable the user to find the desired information without loss of effort or time. The last section, comprising about a third of the book, consists of examples worked out to show the application of the formulas and their methods of application. In this particular field probably the sections on mechanics covering gravity, mass, force, acceleration, work, torque, horsepower, impact, velocities, frictions, specific gravity, flow of liquids, etc., and Section 3 dealing with graphic calculations of forces, bending moments, etc., will prove to be the most useful. The worked examples are well chosen to illustrate the use of the various formulas and add much to the practical value of the book.

LIVING-TOGETHER IN A POWER AGE, by Samuel S. Wyer, published by Association Press, 347 Madison Ave., New York, 1936. Size 6 by 9 in., 231 pages, illustrated. Price $2.50.

The author of this book has been a consulting engineer for many years and presents his views on social problems, dealing particularly with the social changes which have been brought about by engineers in their problems of harnessing the energy of our natural resources. He has divided the book into 11 chapter headings as follows: What Has Happened; Living-Together with Stored Energy; Living-Together with Electric Power; Living-Together on Wheels; Living-Together with Our Farmers; Water Problems of Living-Together; Population Problems of Living-Together; How to Make Plenty Possible for All; Living-Together Planning.

The spirit of this book is probably best expressed by the author's opening paragraph in which he states: "Quietly and blindly and without appreciation of the social implications, the engineer, by harnessing the energy in our natural resources, has unleashed new forces which started the world's worst economic muddle. The pathetic unawareness of the engineer of the social changes he has set in motion, the spiritual unpreparedness of religious leaders to supply proper living-together motives. the inertia of lawyers in adjusting their lagging law thinking to a rapidly moving social order, the lack of understanding of business men of the social consequences of their own business processes and the bewildered and confused educators isolated from reality and

groping in an atmosphere of illusion—these have brought society to the most serious crisis in man's long, slow ascent."

The author presents his subject in a logical manner, relying upon statistics for the basis of his reasoning and deals with all the present day systems of government, including anarchism, socialism, communism, fascism, capitalism and orderly society.

DIESEL ENGINES, OPERATION AND MAINTENANCE. By L. H. Morrison. Published by American Technical Society, Chicago, Ill. Size 5½x8½ in., cloth bound, 206 pp. Price $2.25.

This is the third of a series of books on Diesel engines published by this company (Diesel and Other Internal Combustion Engines by Degler and Diesel Electric Plants by Kates) and covers the Diesel engine from the standpoint of operation and maintenance. It is divided into 18 chapters with the following headings: Cycle; Combustion Principles in Modern Diesels; Installation of Diesels; Crankshafts and Main Bearings; Cylinders and Liners; Valves and Gearing; Pistons and Connecting Rods; Governors; Fuel Injection Nozzles of Solid-injection Diesels; Air Compressors; Cooling Water Systems; Fuel and Fuel Handling Supplies; Lubrication and Lubrication Systems; Exhaust Systems; Air Filtration; Starting Systems; Starting and Running the Engine; Modern Heavy Duty Diesels. The engine has thus been divided into unit parts, each part described in detail, the most common troubles brought out and methods of adjustment and repair suggested.

The book is of value not only to those interested in becoming more familiar with the Diesel engine but to those interested in becoming skilled operators, to operators who have charge of or work in Diesel plants, and, those who have charge of their supervision. The book is well prepared, well illustrated and presented in a simple and practical way.

THE NATIONAL ELECTRICAL CODE HANDBOOK, Third Edition, by Arthur L. Abbott. 547 pp., 5 by 7½ in., semi-flexible fabricoid; fully illustrated. McGraw-Hill Book Co., Inc., New York, 1936. Price $3.

As in the case of the two previous editions, the purpose of this book is to enable the reader to grasp readily the general plan, scope and intent of the National Electrical Code requirements. To present more or less detailed discussions of the rules wherever anything of practical value can be contributed by such discussion and to make the practical application of the rules clear and easily understood. This book is really an interpretation. A copy of the Code itself is not included because this is available to everybody at a nominal price and since the Code is subject to revision from time to time, it is better to refer to the latest Code whenever such reference is necessary. All the requirements of the Code are included but some of the rules have been re-worded where the purpose of the book could be better served by so doing.

The new third edition is essentially the same as the previous edition but incorporates a new feature which should add materially to the practical value of the book. This has to do with the data that must be constantly referred to by inspectors, contractors and engineers. Instead of being scattered throughout the text these are all brought together in the last chapter, making it available for instant reference.

TECHNICAL DATA ON FUEL, fourth edition, 374 pages, 11 folding diagrams, flexible cloth board binding, edited by H. M. Spiers, published by the British National Committee, World Power Conference, 36 Kingsway, London, W.C.2 England. Price, 12 shillings 6 pence.

Originally planned as one of the British contributions to the Fuel Conference in 1928 this valuable handbook has come to its fourth edition, each new printing with added data making the contents of the last edition twice that of the first. Both British and metric units are used, but tables of conversion factors are included to aid in making calculations. The book is an assembly of a mass of physical and chemical data segregated under the following division headings: General Information; Air, Water and Gases; Specific Heat; Thermodynamic Properties of Materials; Thermal Conductivities and Heat Transfer; Metals and Alloys; Refractories; Fuel—General Introduction; Gaseous Fuels; Liquid Fuels; Solid Fuels; Stack Losses; Miscellaneous Thermal Data; and Bibliography.

THE UNIFORM MECHANICS' LIEN ACT. By Myron H. Lewis. 60 pages; 8½ by 11, mimeographed, bound in heavy paper covers. Published by The Rugere Press, 55 W. 42nd St., New York, N. Y. 1936. Price, $2.00.

An explanation and analysis with a tabular and alphabetical index to the New Lien Act and compared with the 1927 compiled Statutes. The Uniform Mechanics' Lien Act according to the author's note has been in the making over ten years, but Florida has the distinction of being the first state to incorporate the act, as finally promulgated into its statute law. The decided changes which the new act makes in the relations of those engaged in the act, not only in Florida, but in all other states makes this indexed reprint timely and useful.

THE MECHANICAL WORLD ELECTRICAL YEAR BOOK, 1936. 313 pp., 4 by 6 in., cloth; fully illustrated. Published by Emmott & Co., Ltd., Mechanical World office, London. Price 1/6 net.

This handy little book which has been issued for many years contains practically all the features of the immediate previous editions but also incorporates some new subject matter. An important development in electrical engineering during the year in Great Britain has been the issue of new regulations and their subsequent amendment by the Institution of Electrical Engineers.

The tables relating to cables and conduit capacity, which have formed a feature of the Electrical Year Book for many years, have been revised to conform with the latest of these regulations. Other new subject matter concerns protective systems for generators, voltage regulation in the section on transmission and distribution and some revisionary matter in the section on lighting. The tables on electrified railways and certain paragraphs adjoining them have been revised and include new lines and extensions opened during the year. There is also, of course, the general data and information which have made the book so useful and popular among all who have to do with or use electrical power and machinery.

PREPARATION OF ENGINEERING REPORTS. By Thomas R. Agg and Walter L. Foster. Published by McGraw-Hill Book Co., Inc., New York City. Size 5 by 7½ in., 187 pages, cloth bound. Price $1.75.

Intended primarily as a text book for a college course on engineeriig reports, the book is unusually complete and in considerably more detail than books of this kind written for practicing engineers usually are. In addition to the actual writing of the report, the book includes suggestions or methods of obtaining and organizing subject matter preparatory to writing the report, shows typical presentation of data in chart and graphic form and outlines the main parts of a formal engineering report. By no means the least valuable section of the book are the four appendices giving suggestions on style with a review of English and grammar; appendix B, accepted abbreviations; appendix C outlining a course in the preparation of engineering reports and appendix D, a list of books and reports for reference.

PHILADELPHIA GEAR WORKS, Philadelphia, Pa., has recently issued a new catalog describing Philadelphia Limitorque automatic valve control. This is an extremely attractive catalog, containing full information on the construction and application of the various types of electrically operated valve control units made by this company. The catalog contains standard specifications, engineering data and charts which enable prospective users to select the proper type of equipment for particular purposes.

A UNIQUE FUEL OIL heater that provides flexible capacity for varying fuel requirements is described in a bulletin which has recently been published by The Griscom-Russell Co. This unit is the patented Twin G-Fin section fuel oil heater and its patented G-Fin heating elements in which the exterior heating surface has more than 8 times the area of the interior cylindrical surface. The bulletin is well illustrated with sectional exterior and installation views of the heater. The bulletin is designated as No. 707 and copies may be obtained by writing direct to The Griscom-Russell Co., New York City.

THE BRISTOL CO., of Waterbury, Conn., has recently published an eight page catalog describing Bristol Ampliset Free-Vane Controllers. These controllers are applicable to the control of temperature, flow, liquid level, pressure, time-pressure and humidity. The bulletin presents complete description of the construction of these controllers and also indicates various applications.

NON-CONDUCTING PIPE COVERING PROTECTION SADDLES is the title of a four page leaflet recently published by the Crawford Co., Chicago, Ill. These insulated pipe supports are designed to insulate all types of piping from supporting rollers or hangers. The leaflet shows the different types available and also presents information regarding sizes and prices.

STAYNEW AUTOMATIC AIR FILTER is the title of Bulletin No. 120 recently issued by the Staynew Filter Corp., Rochester, N. Y. This bulletin describes the Model A type oil impingement filter which is applicable to all ventilating purposes. The bulletin explains the construction and operating features of this equipment and also contains a table giving the capacities for different numbers of sections and for different sizes.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has issued a new leaflet 2224 on their single suction end inlet centrifugal pumps, mounted on substantial pedestals, and used with direct connected or with Texrope V-belt drives. These pumps are bronze fitted and range in size from 1¼ by 1¼ to 5 by 4, for heads up to 100 ft. and over, with many applications in most every industry. In addition to showing the general construction with dimension tables, this leaflet shows a number of typical combination drives. This type of pump can be furnished suitable for use in an inclined or vertical position, as well as horizontal.

SARCO CO., INC., New York, N. Y., has recently issued leaflet No. 140 describing the Sarco Water Blender, a device for automatically mixing hot and cold water, brine or other fluid and which delivers the mixture at any predetermined constant temperature.

WORTHINGTON PUMP AND MACHINERY CORPORATION has just issued two new bulletins, L-611-B11 devoted to Type HB-2 and HS-2 single tandem horizontal two-stage steam and motor-driven compressors, and L-611-B12 devoted to Type HB-3 and HS-3 single horizontal three-stage compressors. Full details and specifications are given.

INTERNAL BOILER FEEDWATER TREATMENT as practiced by the Permutit Co., 330 W. 42nd St., New York, is described in detail in an 8 p. bulletin just issued. There are three general classes of chemicals used in this treatment, precipitants, coagulants and retardants, selected and blended to meet each set of operating conditions.

DETAILS OF CONSTRUCTION, operation and design of nine sizes of stokers to fit every type of heating or power installation up to 250 hp., are covered in a 16 p. booklet on Bardes automatic stokers published by the Bardes Stoker Works, Cincinnati, O. These stokers are of the single retort, under-feed type with screw feed and an integral fan, both driven by a single motor.

THE LINCOLN ELECTRIC CO., Cleveland, Ohio, is distributing a new engineering drafting room chart which presents in ready reference form the data necessary for arc welded designs.

BEAVER PIPE TOOLS, INC., Warren, Ohio, have just published a new 8 page bulletin covering Beaver Model A special and standard pipe machines. This bulletin is complete in descriptive detail and presents a description of the performance of the various machines. It also includes a page giving prices, shipping weights and code words.

HIGH SPEED CIRCUIT breakers is the title of Bulletin 436 recently issued by the I-T-E Circuit Breaker Co., Philadelphia, Pa. This bulletin describes a new high speed circuit breaker which is ideally suited for application as a feeder breaker in steel mills, direct current railway systems and large industrial concerns where extremely high power concentration exists. The Type OH breaker which this bulletin describes has a maximum continuous rating of 10,000 amps. at either 600 or 1500 v. A particular feature of this breaker is the rate-of-current-rise-element which causes the breaker to operate not only in accordance with the total amount of current carried, but also at the rate at which the current rises per unit of time.

NATIONAL PREMIER Jacketed Vertical steel boilers, built in two sizes, 23 and 26 in. firepot diameters and arranged for automatic firing, are described in a new bulletin of the National Radiator Corp., Johnstown, Pa.

HANCOCK FORGED Steel Valve is the title of Bulletin 7000 issued by Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn. The bulletin describes the new line of valves for all steam pressure ranges up to 1500 lb. per sq. in. and calls attention to a number of distinctive features of these new valves.

THE LINDE AIR PRODUCTS CO., 205 E. 42nd St., New York City, has just published a booklet on Welding and Cutting High Chromium Steels which presents the latest information on this subject. This booklet is a reprint of a paper read before the International Acetylene Association and gives data on improved methods based on properties of chromium alloys.

NON-CLOGGING CENTRIFUGAL PUMPS of a new design are described by a four-page bulletin, No. 160, of the Morris Machine Works, Baldwinsville, N. Y.

THE EDWARD VALVE & MFG. CO., INC., East Chicago, Ind., has issued its catalog No. 11-A10 the major theme of which is service requirements for high temperatures and high pressures. It is entitled "Valve Material Specifications and Standards" and contains complete chemical analyses and physical rejection limits of all applicable specifications of recognized standing. There are also discussions of special subjects such as alloying elements, corrosion resistance, heat treatment, high temperatures, status of standards, and valve materials.

DIESELS AND PROFITS, a 16-p. booklet issued by Fairbanks, Morse & Co., Chicago, Ill., discusses the reduction in cost of power which has been secured in many cases by the use of Diesel engines, and describes the various types of F-M four, six and seven-cylinder engines for 4-stroke and 2-stroke cycles. Services in which these engines have made good are illustrated, also the method of utilizing heat from exhaust to heat water. It is an interesting and impressive showing of the wide application of this form of prime mover.

THE BONNEY FORGE & TOOL WORKS, Allentown, Pa., in its Bulletin No. WT21, describes Bonney Weldolets and Thredolets and illustrates in detail the many types of jobs on which these pipe welding fittings can be used to advantage.

LINK-BELT CO., Chicago, has just published a new 208-page catalog No. 1500 devoted exclusively to power transmission equipment, which features the recently announced line of Link-Belt anti-friction roller bearing units, as well as an entirely new group of streamlined babbited bearings, several new types of take-ups, and many other new products, such as drop hangers, cast iron and pressed steel; pulleys of all types, gearing, cast and cut tooth types; shafting couplings, safety collars and grease fittings. The book, which contains many illustrations, gives dimensions, weights and list prices, and contains a cross reference index for convenient use of engineers and plant managers, is offered to anyone interested in power transmission equipment on request to Link-Belt Co., Chicago.

"CUBICLES" WITH FH Oil-blast breakers up to 15,000 v. service is the title folder GEA-2326 recently issued by General Electric Co. GEA-941B which supersedes GEA-941A also new, is devoted to motor driven reciprocating air compressors.

BLOWERS, heaters and louvres as built by the Autovent Fan & Blower Co., 1805 North Kostner Ave., Chicago, Ill., are covered in a new bulletin just issued.

KABLE KORD BELTS and belting, a flat belt particularly designed for grip and so constructed that it resists stretch to an unusual degree, are covered in a new catalog recently issued by L. H. Gilmer Co., Tacony, Philadelphia, Pa. Gilmer V-Belts, also with data tables and with a large chart for calculating center distances, are covered by a second catalog of 32 pages.

GARRISON ENGINEERING CORP., Great Barrington, Mass., has recently published a brochure entitled Garrison—The Modern Dry Method of Fire Extinguishment which explains very simply and in detail how to go about the control of fire and describes the Garrison method and apparatus used for fire fighting.

LIQUID LEVEL CONTROLLERS for all services are covered in a new bulletin, Section H2 of Catalogue 35, of the McAlear Mfg. Co., 1901 S. Western Ave., Chicago. This is a 72 page booklet illustrating and describing the various types of controllers and including a number of curves and charts showing the flow through regulating valves of different types.

OPERATION AND CONSTRUCTION of the slide valve used by the Chambersburg Engineering Company, Inc., Chambersburg, Pa., in its steam drop hammers and hydraulic presses is graphically displayed in an action model which the company is distributing to interested engineers.

AMERICAN CAR AND FOUNDRY CO., 30 Church St., New York, N. Y., has recently issued its catalog No. 2 dealing with A. C. F. Full Area Lubricated Plug Valves suitable for gasoline, oil, water, air, gas, vacuum, steam boiler blow-off, chemicals, caustic solutions and other fluids.

A NEW PRECISION HONE especially adapted to assembly, short-run production, tool room, experimental work and general plant maintenance is covered by a four page bulletin issued by the Sunnen Products Co., 7900 Manchester Ave., St. Louis, Mo.

HOW TO MAKE PLANT SURVEYS with graphic instruments is discussed in considerable detail in a 12 page Bulletin No. 336 of the Esterline-Angus Co., Indianapolis, Ind.

AXIAL FLOW IMPULSE TURBINES as built by the Terry Steam Turbine Co., Hartford, Conn., are described in an eight page bulletin, S-107.

SOOT BLOWERS, their design, application and typical installations are covered in a new 40 page bulletin, in colors, just issued by the Diamond Power Specialty Corp., Detroit, Mich. In contrast to past practice, the operating parts inside the boiler, which play such an important part in a successful installation, have been given equal attention with the operating head.

PUMPS designed specifically for handling acids, alkalis, brine, hot or cold water and other corrosive fluids are described in a recent bulletin issued by the Lawrence Pump & Engine Co., Lawrence, Mass. These VS type pumps are built in a variety of models for different needs.

ANNOUNCEMENT is made by Link-Belt Co., Indianapolis, Ind., of the completion of its 24-page book No. 1557, in which are tabulated the cut-tooth sprocket wheels now available with Silverlink finished-steel roller chains, from stocks carried at the company's plants and warehouses, and by authorized distributors. A copy may be had by addressing Link-Belt Co., 519 N. Holmes Ave., Indianapolis, Ind.

COMM O LECTRIC steam generators, heated by electricity, as produced by Commonwealth Elec. & Mfg. Co., Boston, Mass., in capacities for 9 to 72 lb. steam per hr. for pressures of 100, 200 or 300 lb. per sq. in. are described and illustrated in Bulletin No. 52B recently received.

Power Plant Construction News

Ark., Little Rock—Terry Dairy Co., Scott St., plans installation of electric power equipment in new one and two-story addition to milk products plant. Entire project will cost about $50,000. Work scheduled to begin soon.

Calif., Kingsburg—Muscat Co-operative Winery Association, C. W. Tremper, manager, plans installation of electric power equipment in new additions to plant on Mountain View Avenue. Entire project will cost about $100,000. Work will begin at early date. H. R. Lake, Pacific Southwest Building, Fresno, Calif., is architect.

Colo., Boulder — Boulder Minerals Corporation, Boulder, A. A. Zangara, president, plans installation of electric power equipment in new ore reduction mill, with flotation, roasting and cyanide departments, at gold-mining properties near Boulder. Entire project will cost over $150,000. Work is scheduled to begin in July.

Conn., Hartford—Olds & Whipple, Inc., 166 State St., plans installation of electric power equipment in new one-story addition to commercial fertilizer works, 135 x 145 ft. Entire project will cost over $80,000. Mylchreest & Reynolds, 238 Palm St., are architects and engineers.

Fla., Orlando—Atlantic Ice & Coal Corporation, 37 North Thirteenth St., Chattanooga, Tenn., plans installation of power equipment, conveying, loading and other mechanical equipment in new multi-story brewing plant at Orlando. A boiler house will be built. Entire project is estimated to cost over $200,000.

Ga., Albany—Cudahy Packing Co., 221 North La Salle Street, Chicago, Ill., meat packer, plans installation of electric power equipment in new branch plant at Albany, where large tract of land was recently acquired, including main unit, 125 x 435 ft., and other buildings, with boiler house. Entire project will cost about $500,000. Work will begin at early date. H. J. Byrnes, company plant, Omaha, Neb., is chief engineer.

Ill., Chicago—Pheoll Mfg. Co., 5700 West Roosevelt Road, manufacturer of screws, bolts, nuts, etc., plans installation of electric power equipment in new one-story addition. Entire project will cost close to $100,000. Alfred S. Alschuler, 28 East Jackson Blvd., is architect.

Ill., Monsanto—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., has plans under way for extensions and improvements in power house at plant at Monsanto, with installation of two new high-pressure boiler units, forced draft equipment, chain grate stokers, pumps and auxiliary equipment. Entire project will cost about $550,000. Stone & Webster Engineering Corporation, 49 Federal St., Boston, Mass., is consulting engineer.

Ind., Anderson—Board of Education plans new steam power plant for central heating service at senior and junior high schools. Cost about $40,000. E. F. Miller, Anderson Bank Building, Anderson, is architect.

Iowa, Alta—At recent special election, citizens have authorized Common Council to arrange bond issue of $75,000 for extensions and improvements in municipal electric light and power plant, including installation of new Diesel engine unit and auxiliary equipment. Proposed to begin work soon.

Iowa, Rockwell City—City Council has plans under way for new municipal electric light and power plant, and proposes to begin work in near future. Cost about $175,000. Young & Stanley, Muscatine, Iowa, are consulting engineers.

Kan., Kansas City—Board of Public Utilities, City Hall, Charles A. Lowder, secretary, will receive bids until July 8 for new 30,000 kw. turbo-generator unit with complete accessory equipment, and for 40,000 sq. ft. capacity condenser with auxiliaries, for installation in municipal power plant. Other equipment will be installed, for which bids will be asked soon. Entire project will cost about $1,500,000. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., is consulting engineer.

Kan., St. Francis—Common Council plans extensions and improvements in municipal electric light and power plant, including installation of new Diesel engine-generating unit and accessories. Cost about $85,000. E. T. Archer & Co., New England Building, Kansas City, Mo., are consulting engineers.

Ky., Lexington—City Council plans installation of large pumping plant in connection with extensions and improvements in municipal waterworks; also, two 500,000-gal. elevated steel tanks and towers, 2,000,000-gal. capacity steel standpipe, pipe lines and other equipment. Entire project estimated to cost about $3,700,000. Howard K. Bell and J. S. Watkins, Lexington, are engineers.

Ky., Williamstown—Fischer & McGee, Inc., Williamstown, care of H. A. Churchill & Associates, Citizens' Trust Building, Lexington, Ky., architects, plans installation of electric power equipment in new distilling plant at Williamstown, comprising several one and multi-story units. A boiler house will be built. Entire project will cost in excess of $100,000. Architects noted are in charge.

Me., Togus — Construction Service, Veterans' Administration, Washington, D. C., will receive bids until July 14 for boiler and boiler plant equipment, steam lines, etc., in connection with additions and improvements in buildings at institution at Togus, as per plans and specifications on file.

Md., Baltimore—Noble Woodworking Co., 3203 Noble St., plans installation of electric power equipment in new one-story plant, 100x160 ft., on Luzerne Avenue. Cost about $65,000. J. E. Moxley, 3214 Westwood Ave., is architect.

Mich., Detroit—Detroit Forging Co., 3564 Toledo St., plans installation of electric power equipment, conveying machinery and other mechanical-handling equipment in new plant additions. Entire project will cost over $200,000. Work is scheduled to begin soon. Norman H. Macqueen is president.

Mich., Detroit—Kraft Brewing Co., 1800 East Forest St., plans installation of power equipment, conveying machinery and other mechanical equipment in connection with expansion and improvements in brewing plant to increase present capacity from 60,000 to 120,000 bbl. per annum. Cost over $150,000. Edmund J. Boell is secretary and treasurer.

Minn., Litchfield—Litchfield Woolen Mills, Inc., plans installation of electric power equipment in connection with rebuilding of portion of plant, recently destroyed by fire. Loss over $65,000. E. E. Strouts is vice-president in charge of production.

Minn., St. Cloud—Construction Service, Veterans' Administration, Washington, D. C., will receive bids until July 7 for boilers and boiler plant equipment, steam lines and electrical installation in proposed new buildings Nos. 48 and 49 at institution at St. Cloud, as per plans and specifications on file.

N. Y., Buffalo—Iroquois Beverage Corporation, 230 Pratt St., plans installation of power equipment in connection with expansion and improvement program at brewery. New addition will be built. Entire project will cost over $350,000.

Ohio, Harrison—George H. Frederick Distilleries, Inc., Cincinnati, Ohio, care of George H. Frederick, 4749 Glenway Ave., president, recently organized, plans installation of electric power equipment in new distillery on tract of land acquired in Dearborn County, Ind., opposite Harrison. Plant will comprise several units. A boiler house will be built. Cost about $250,000. Financing is being arranged.

Ohio, Newton Falls—Village Council has authorized plans and specifications for new municipal electric light and power plant. Bids will be asked at early date. Cost about $160,000.

Va., Fredericksburg — Sylvania Industrial Corporation plans installation of electric power equipment in new addition to local transparent cellulose paper manufacturing plant. Entire project will cost over $80,000. Ballinger Co., 105 South 12th St., Philadelphia, Pa., is architect and engineer. Main offices of company are at 122 East 42nd St., New York, N. Y.

W. Va., Rivesville — Monongahela-West Penn Public Service Co., Fairmont, W. Va., has plans maturing for expansion and improvements in steam-operated generating plant at Rivesville, to increase capacity from 40,000 to 65,000 kw. Contract for generating unit has been awarded to General Electric Co., Schenectady, N. Y. Awards for other equipment will be made in near future. Extensions will be made in transmission lines. Entire project will cost over $2,000,000. Sanderson & Porter, 52 William St., New York, N. Y., are consulting engineers.

Wis., Fond du Lac—Wisconsin Power & Light Co., 122 West Washington Ave., Madison, Wis., has approved plans for new addition to water-gas generating plant at Fond du Lac, and will begin work soon. Cost over $75,000.

Wis., Portage—Portage Hosiery Co., plans installation of electric power equipment in new two-story and basement addition to knitting mill, 60x118 ft. Entire project will cost close to $70,000. Livermore & Samuelson, 2 South Carroll St., Madison, Wis., are architects. William H. Ziock is manager.

Wis., Racine—Twin Disc Clutch Co., 1328 Racine Ave., plans installation of electric power equipment in new two-story plant unit, 60x120 ft. Cost about $60,000. Frank J. Hoffman, Janes Building, is architect.